United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
North Dakota Agricultural
Experiment Station,
North Dakota Cooperative
Extension Service, and
North Dakota State Soil
Conservation Committee

Soil Survey of McHenry County, North Dakota

How To Use This Soil Survey

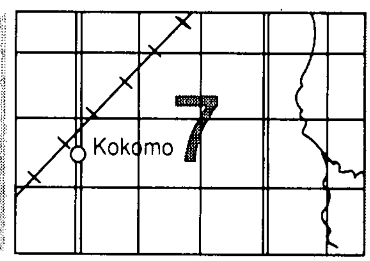
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

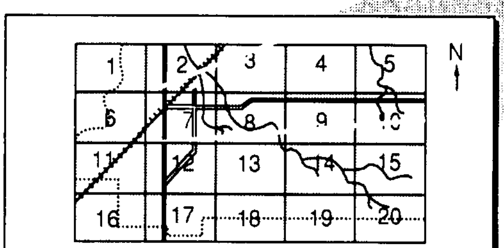
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



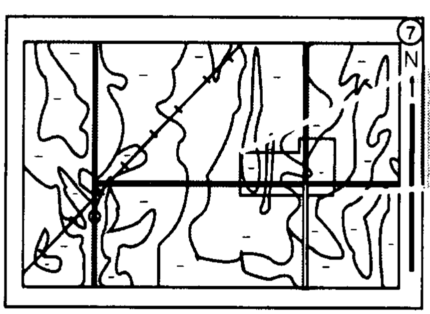
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

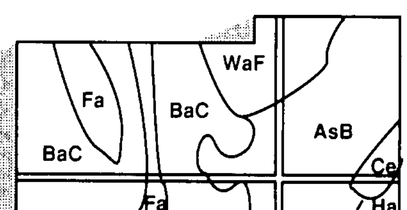


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service, the North Dakota Agricultural Experiment Station, the North Dakota Cooperative Extension Service, and the North Dakota State Soil Conservation Committee. It is part of the technical assistance furnished to the North McHenry County and South McHenry County Soil Conservation Districts. Financial assistance was provided by the McHenry County Board of Commissioners and the North Dakota Department of University and School Lands.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Typical area of McHenry County. Buse, Dickey, and Maddock soils in foreground are used as range. Aylmer soils are on rises and Bantry soils are in swales in background. Trees scattered throughout the area are dominantly quaking aspen.

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Issued October 1990

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Foreword

This soil survey contains information that can be used in land-planning programs in McHenry County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of
McHenry County, North Dakota

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United States Department of Agriculture, Soil Conservation Service,
in cooperation with
North Dakota Agricultural Experiment Station, North Dakota Cooperative Extension Service,
and North Dakota State Soil Conservation Committee

McHenry County is in the north-central part of North Dakota (fig. 1). It has a total area of 1,223,800 acres, or 1,912 square miles. Towner is the county seat.

Farming and ranching are the main economic enterprises. The principal crops are spring wheat, barley, sunflowers, and hay.

All of the soils in the survey area are deep. They are suited to cultivated crops and to pasture, range, and hay. A large number of the soils that are used primarily for range have a sandy surface layer and a seasonal high water table. Soil blowing is a hazard on these soils as well as on those that have a limy surface layer. The sandy and gravelly soils in the survey area formed in glaciofluvial deposits and have a very low or low available water capacity. The level to moderately sloping, loamy soils that formed in till and the silty and loamy soils that formed in glaciolacustrine deposits generally are highly productive. Water erosion is a hazard on the gently sloping to very steep soils that formed in till.

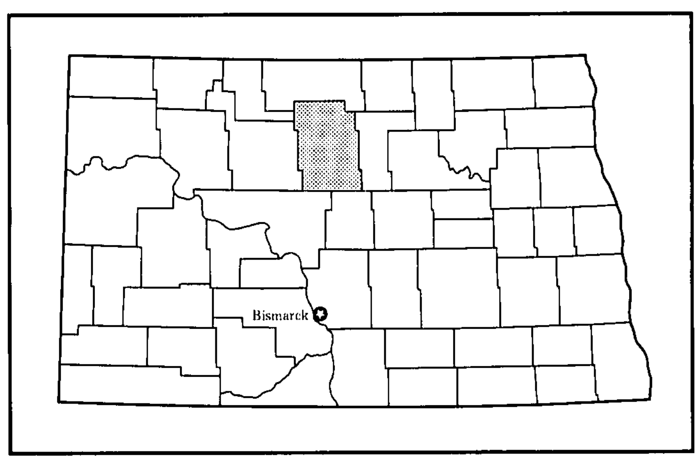

Figure 1.—Location of McHenry County in North Dakota.

This survey updates the survey of McHenry County published in the *Soil Survey of Western North Dakota* in

1910 *(8)*, the *Soil Survey of McHenry County, North Dakota*, published in 1921 *(12)*, the general soil map published in 1963 *(7)*, and a bulletin published in 1968 *(11)*.

General Nature of the County

This section provides general information about the history and development; farming and ranching; geology, physiography, and drainage; and climate of the county.

History and Development

McHenry County was established in 1873 by an act of the Dakota Territorial Legislature. It was organized on February 19, 1885, by the Legislative Assembly of the Territory of Dakota.

Settlement of the county began with the arrival of ranchers in 1882. These ranchers first settled mostly in the Towner area and then spread out to other parts of the county, where less land had been claimed.

Settlement by farmers began in about 1901, and by 1905 most of the land had been claimed. With the settlement by farmers, the original ranching industry died out.

The city of Towner, originally named Newport, was located on the west side of the Souris River, about 4 miles west of the present site of Towner. When the railroad came, the townsite was changed to the present location along the railroad. Later that year, on December 18, 1886, Towner became the county seat *(5)*.

In 1880 there were virtually no settlers in McHenry County, but by 1890 the population was 1,584. In 1910 the population peaked at 17,637. In 1970 the population was 8,977, and by 1980 it had decreased to 7,850.

Farming and Ranching

Farming and ranching are the most important industries in McHenry County. By 1900 there were about 1,104 farms and ranches in the county. The number peaked at 2,329 in 1910, and then it gradually decreased to a total of 974 in 1982 *(15)*. Raising livestock is an important enterprise in McHenry County. About 31 percent of the county is rangeland. In 1985 there were about 72,000 cattle in McHenry County. Of these, 3,600 were milk cows. There were also about 4,000 sheep *(9)*.

Grain farming is an equally important enterprise in McHenry County. About 60 percent of the county is cultivated. The major crops planted are hard red spring wheat, durum wheat, and sunflowers. Other important cover crops are barley, flax, oats, rye, and winter wheat. Alfalfa is the most important forage crop.

Irrigation farming is extensive in the Karlsruhe area. This area is underlain by the New Rockford aquifer system, which is the largest producing aquifer of high quality water in the county.

Geology, Physiography, and Drainage

The Glaciated Plains cover all of McHenry County except for about 30 square miles in the southwesternmost corner, which is on the Missouri Coteau (fig. 2). The Glaciated Plains can be divided into two areas. The glacial Lake Souris plain, in the northeastern part of the county, makes up about 60 percent of the county; the rest, to the south and southwest, is till plain. The lake plain has been modified in many areas by soil blowing and in some places is, in part, covered by sand dunes. The till plain is highly fluted in places and is characterized by drumlinlike features (long, linear ridges) *(4)*. The most prominent of these is Hogback Ridge, which extends 13.5 miles, from Verendrye to Balfour.

Relief in McHenry County is mostly low to moderate. Relief is highest in areas of sand dunes and on some ice-thrust hills, where it is as much as 100 feet.

Elevation in McHenry County ranges from 1,420 feet, where the Souris River leaves the county, to more than 2,000 feet, on the Missouri Coteau.

McHenry County is drained mostly by the Souris River and its tributaries; the southeastern corner of the county, however, is drained by the Sheyenne River system.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

McHenry County is usually quite warm in summer, but there are frequent spells of hot weather and occasional cool days. It is very cold in winter, when arctic air frequently surges over the area. Most precipitation falls during the warm period, and it is normally heaviest late in spring and early in summer. Winter snowfall usually is not too heavy, and it is blown into drifts so that much of the ground is free of snow.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Granville in the period 1951-81. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3

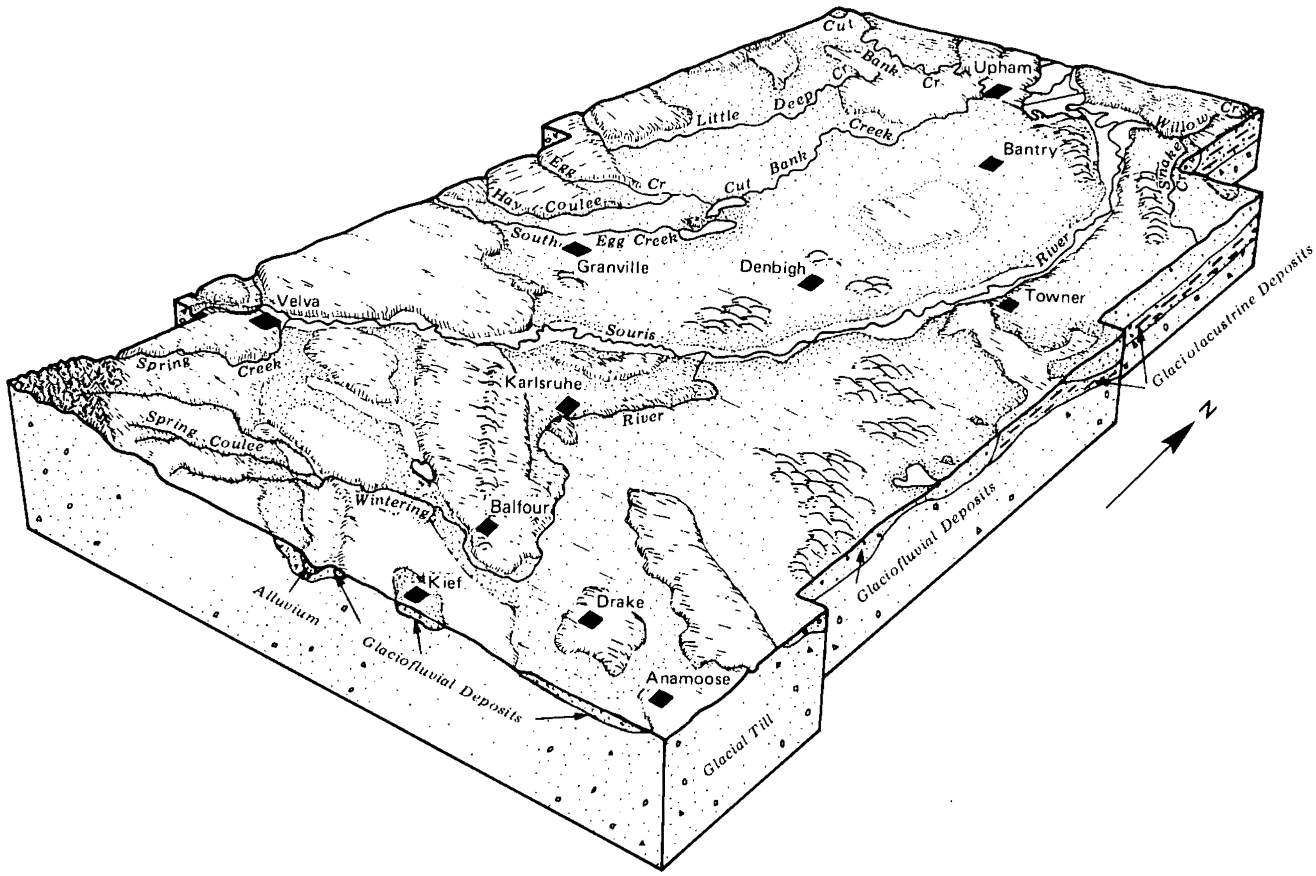

Figure 2.—Physiographic features of McHenry County, North Dakota.

provides data on length of the growing season.

In winter the average temperature is 10 degrees F, and the average daily minimum temperature is 0 degrees. The lowest temperature on record, which occurred at Granville on January 4, 1968, is -40 degrees. In summer the average temperature is 67 degrees, and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred at Granville on July 20, 1960, is 106 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 13 inches. Of this, 10.4 inches, or 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the total rainfall in April through September is less than 11 inches. The heaviest 1-day rainfall during the period of record was 3.7 inches at Granville on August 24, 1968. Thunderstorms occur on about 28 days each year.

The average seasonal snowfall is about 32 inches. The greatest snow depth at any one time during the period of record was 48 inches. On the average, 56 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 11 miles per hour, in spring.

Several times each winter, storms with snow and high wind bring blizzard conditions to the area. Hail during summer thunderstorms occurs in small, scattered areas.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is

identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Survey Procedures

The general procedures used to make this survey are described in the National Soils Handbook and the *Soil Survey Manual (13)*. The *Major Soils of North Dakota (10)*, *Geology of McHenry County, North Dakota (4)*, *General Soil Map, McHenry County (7)*, *Soil Survey Report, County General Soil Maps (11)*, and *Soil Survey of McHenry County, North Dakota (12)* are among the references used.

Traverses were made on foot, by pickup, or by all-terrain motorcycles at an interval close enough to locate contrasting soil areas of about 3 acres. All map units were characterized by transecting representative units. For each 1,000 acres of the unit mapped, a minimum of 2 transects to a maximum of 10 transects was required. Data collected from the transects were analyzed by a statistical method explained by R.W. Arnold *(3)* and used to justify names and establish the range of composition of each map unit. This statistical analysis indicates that the average map unit composition given in the map unit descriptions is at least 90 percent accurate.

The range of average composition of most of the map unit complexes is not wide; however, two units do have a wide range. Map units Aylmer-Minnewaukan complex, 0 to 6 percent slopes, and Claire-Lohnes coarse sands, 1 to 6 percent slopes, hummocky, have a wide range of average composition. This is because of the greater variability in the kinds of soil in these units.

Each soil map unit was documented by at least one to three pedon descriptions for each soil series used in its name. In 1984 soil samples were collected on 11 pedons for characterization. The samples were analyzed by the North Dakota State University Soil Characterization Laboratory. An additional 64 pedons were sampled and analyzed by North Dakota State University and the United States Department of the Interior, Bureau of Reclamation, for characterization.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Some of the boundaries and soil names on the general soil map of McHenry County do not match those on the maps of Bottineau, Pierce, McLean, and Ward Counties. The differences are a result of improvements in the classification of soils, particularly in modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

Soil Descriptions

Level to Hilly, Sandy and Loamy Soils on Delta Plains and Outwash Plains

These soils formed in glaciofluvial deposits. They make up about 49 percent of the county. Most areas are used as range, but some are used for hay, pasture, and cultivated crops. The soils are well suited to hay, range, and pasture but are poorly suited to cultivated crops. The main concerns in managing range are maintaining an adequate cover of the important forage plants, preventing denuding, and controlling soil blowing.

1. Hecla-Aylmer-Ulen Association

Deep, coarse textured and moderately coarse textured, level to undulating, moderately well drained and somewhat poorly drained soils

This association is on rises and flats and in swales on windblown delta plains. Slopes generally are short and choppy. A few depressions are throughout most areas. Slope ranges from 0 to 6 percent.

This association makes up about 36 percent of the county. It is about 25 percent Hecla and similar soils, 21 percent Aylmer and similar soils, 16 percent Ulen soils, and 38 percent soils of minor extent (fig. 3).

The level and nearly level, moderately well drained Hecla soils are on the flats and in the swales. Typically, the surface soil is very dark gray. It is about 15 inches thick. It is loamy fine sand in the upper part and fine sand in the lower part. The next layer is very dark grayish brown fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and light olive brown in the lower part.

The level to undulating, moderately well drained Aylmer soils are on the rises. Typically, the surface layer is black fine sand about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. In sequence downward, it is dark grayish brown, dark grayish brown and mottled, black and mottled, and grayish brown and mottled.

The level and nearly level, somewhat poorly drained Ulen soils are on the flats around depressions. Typically, the surface soil is about 11 inches thick. It is black loamy fine sand or fine sandy loam in the upper part and very dark grayish brown loamy fine sand in the lower part. The subsoil is loamy fine sand about 23 inches thick. It is dark grayish brown in the upper part and brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled fine sand.

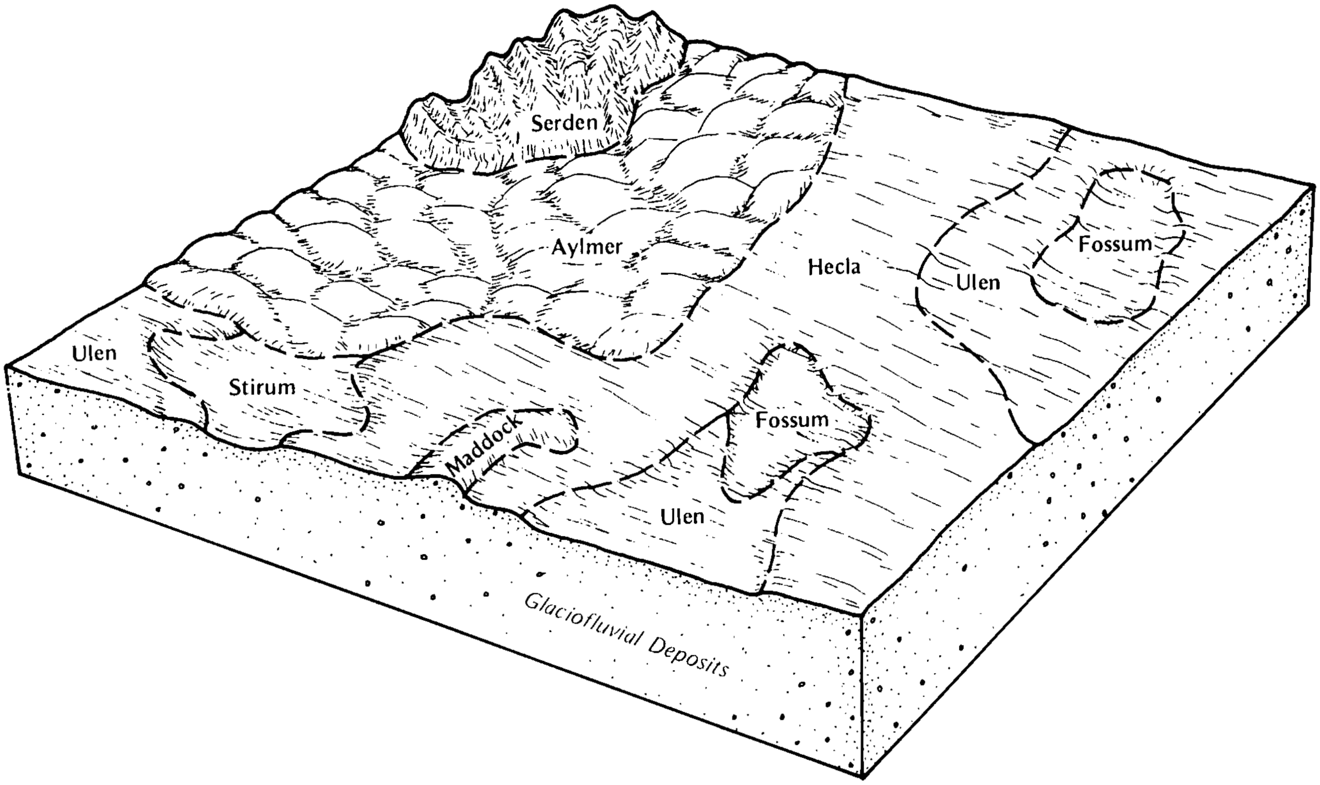

Figure 3.—Typical pattern of soils and parent material in the Hecla-Aylmer-Ulen association.

Bantry, Fossum, Maddock, Serden, and Stirum are the principal minor soils in this association. The somewhat poorly drained Bantry soils are in swales below the Aylmer soils. The poorly drained Fossum and Stirum soils are in depressions. The well drained Maddock soils are on knolls above the Hecla soils. The excessively drained Serden soils are on dunes and ridges above the Aylmer soils.

Most areas are used for hay, range, and pasture, but some are used for cultivated crops. The association is poorly suited to cultivated crops, but it is well suited to hay, range, and pasture. The main concerns in managing range are maintaining an adequate cover of the important forage plants, preventing denuding, and controlling soil blowing. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

The main limitations affecting building sites are the seasonal high water table and caving in of walls in basement excavations. The main limitation affecting septic tank absorption fields is the possible pollution of ground water.

2. Lohnes-Falsen-Karlsruhe Association

Deep, coarse textured and moderately coarse textured, level to rolling, well drained to somewhat poorly drained soils

This association is on slight rises and flats and in swales on outwash plains and delta plains. Slopes generally are long and smooth. A few depressions are throughout most areas. Slope ranges from 0 to 15 percent.

This association makes up about 9 percent of the county. It is about 48 percent Lohnes soils, 19 percent Falsen soils, 18 percent Karlsruhe soils, and 15 percent soils of minor extent.

The level to rolling, well drained Lohnes soils are on the rises and flats. Typically, the surface soil is black coarse sand about 11 inches thick. The subsoil is coarse sand about 17 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and dark yellowish brown in the lower part.

The level and nearly level, moderately well drained

Falsen soils are in the swales. Typically, the surface layer is black coarse sand about 12 inches thick. The subsoil is very dark grayish brown coarse sand about 13 inches thick. The next layer is very dark grayish brown, mottled coarse sand. The substratum to a depth of about 60 inches is mottled coarse sand. It is grayish brown in the upper part and light olive brown in the lower part.

The level and nearly level, somewhat poorly drained Karlsruhe soils are on the flats. Typically, the surface layer is coarse sandy loam or sandy loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark gray loamy coarse sand about 4 inches thick. The subsoil is very dark grayish brown, mottled loamy coarse sand about 5 inches thick. The next layer is dark brown, mottled coarse sand about 10 inches thick. The substratum to a depth of about 60 inches is mottled coarse sand. It is very dark grayish brown in the upper part and dark grayish brown in the lower part.

Colvin and Verendrye are the principal minor soils in this association. The very poorly drained Colvin soils and the poorly drained Verendrye soils are in depressions.

Most areas are used for hay, range, and pasture, but some are used for cultivated crops. The association is poorly suited to cultivated crops, but it is well suited to hay, range, and pasture. The main concerns in managing range are maintaining an adequate cover of the important forage plants, preventing denuding, and controlling soil blowing. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

The main limitations affecting building sites are the seasonal high water table in the Falsen and Karlsruhe soils and caving in of walls in basement excavations. The main limitation for septic tank absorption fields is possible pollution of ground water.

3. Arvilla-Sioux-Lohnes Association

Deep, moderately coarse textured and coarse textured, level to hilly, excessively drained to well drained soils

This association is on slight rises, knolls, and ridges on outwash plains. Slopes generally are short and irregular. A few depressions and flats are throughout most areas. Slope ranges from 0 to 25 percent.

This association makes up about 4 percent of the county. It is about 41 percent Arvilla soils, 28 percent Sioux soils, 17 percent Lohnes soils, and 14 percent soils of minor extent.

The level to undulating, somewhat excessively drained Arvilla soils are on the rises. Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is sandy loam about 8 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is dark brown gravelly coarse sand.

The nearly level to hilly, excessively drained Sioux soils are on the knolls and ridges. Typically, the surface layer is very dark gray gravelly sandy loam about 5 inches thick. The next layer is very dark grayish brown gravelly loamy sand about 2 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand.

The level to rolling, well drained Lohnes soils are on the rises, knolls, and ridges. Typically, the surface soil is black coarse sand about 11 inches thick. The subsoil is coarse sand about 17 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and dark yellowish brown in the lower part.

Divide and Verendrye are the principal minor soils in this association. The somewhat poorly drained Divide soils are on flats. The poorly drained Verendrye soils are in depressions.

Most areas are used for cultivated crops. The association is poorly suited to cultivated crops, but it is suited to hay, range, and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The main concerns in managing range are controlling soil blowing, preventing denuding, and maintaining an adequate cover of the important forage plants. The main limitation for building sites is caving in of walls in basement excavations. The main limitation for septic tank absorption fields is the possible pollution of ground water.

Level to Very Steep, Loamy and Silty Soils on Till Plains and Moraines

These soils formed in glacial till and alluvium. They make up about 27 percent of the county. Most areas are used for cultivated crops, but some are used as range. The soils generally are well suited to cultivated crops, hay, range, and pasture. The main concern in managing cultivated areas is controlling water erosion and soil blowing.

4. Barnes-Svea-Buse Association

Deep, medium textured, level to hilly, well drained and moderately well drained soils

This association is on rises, flats, and knolls and in

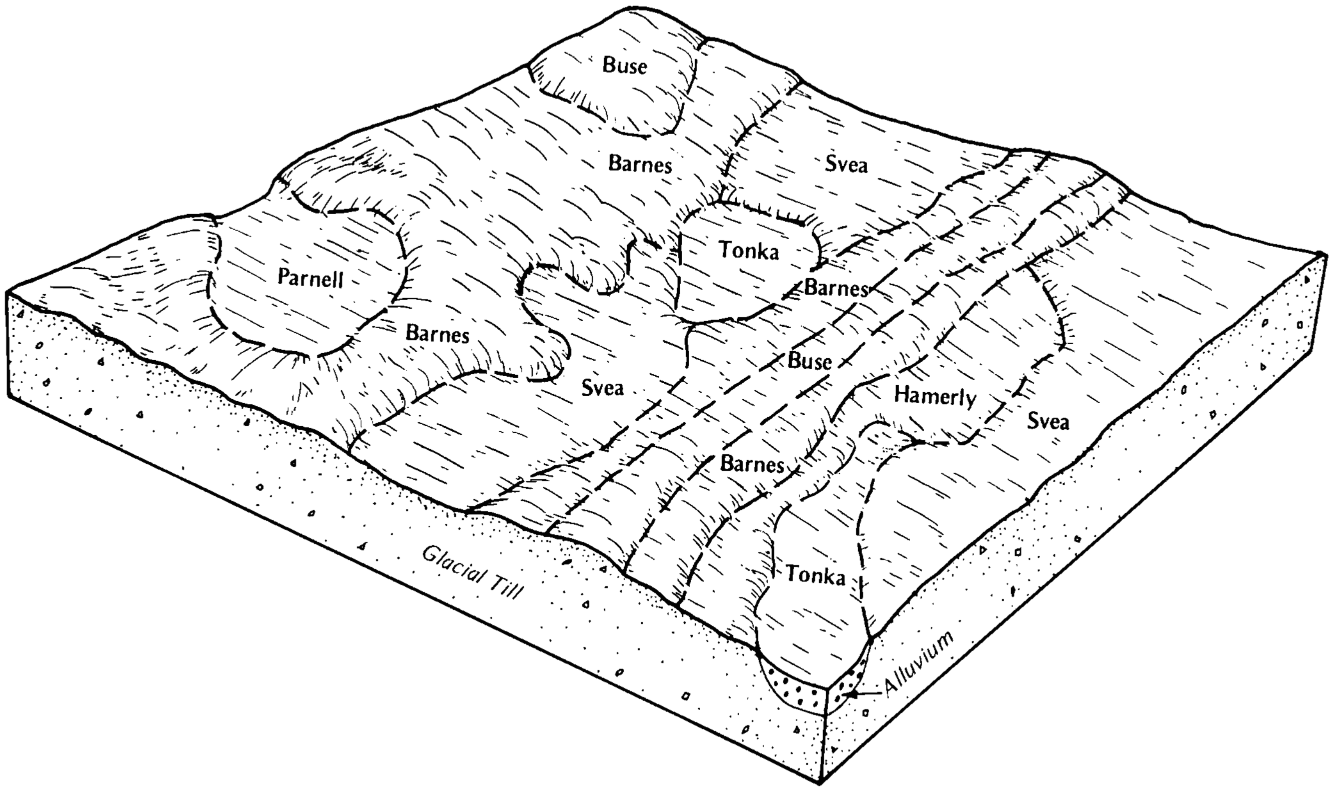

Figure 4.—Typical pattern of soils and parent material in the Barnes-Svea-Buse association.

swales on till plains and moraines. Slopes generally are short and irregular. A few depressions are throughout most areas. Slope ranges from 0 to 25 percent.

This association makes up about 13 percent of the county. It is about 42 percent Barnes soils, 21 percent Svea soils, 12 percent Buse soils, and 25 percent soils of minor extent (fig. 4).

The level to hilly, well drained Barnes soils are on the rises and flats. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam.

The level to undulating, moderately well drained Svea soils are in the swales. Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 23 inches thick. It is very dark gray loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The next layer is light olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

The undulating to hilly, well drained Buse soils are on the knolls. Typically, the surface layer is very dark gray loam about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam.

Hamerly, Parnell, and Tonka are the principal minor soils in this association. The somewhat poorly drained Hamerly soils are on flats around depressions. They have an accumulation of lime within a depth of 16 inches. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions.

Most areas are used for cultivated crops; however, the steeper areas generally are used as range and pasture. The association is well suited to cultivated crops, hay, range, and pasture. The minor Tonka and Parnell soils are well suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range or pasture is maintaining an adequate cover of the important native or introduced forage plants.

The main limitation affecting building sites is the shrink-swell potential. The main limitation affecting

septic tank absorption fields is moderately slow permeability.

5. Barnes-Cresbard-Cavour Association

Deep, medium textured, level to undulating, well drained and moderately well drained soils

This association is on rises and in swales on till plains. Slopes generally are long and smooth. Depressions, flats, and knolls are throughout most areas. Slope ranges from 0 to 6 percent.

This association makes up about 8 percent of the county. It is about 42 percent Barnes soils, 21 percent Cresbard soils, 17 percent Cavour soils, and 20 percent soils of minor extent.

The level to undulating, well drained Barnes soils are on the rises. Typically, the surface layer is black loam about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam.

The level to undulating, moderately well drained, alkali Cresbard soils are in the swales. Typically, the surface layer is black loam about 8 inches thick. The next layer is very dark brown and very dark grayish brown loam about 3 inches thick. The subsoil is about 12 inches thick. It is dense, dark brown clay loam in the upper part and olive brown loam in the lower part. The next layer is olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

The level and nearly level, moderately well drained, alkali Cavour soils are in the swales. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is clay loam about 18 inches thick. It is dense and very dark gray in the upper part, dense and dark grayish brown in the next part, and olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is light olive brown in the upper part and dark gray in the lower part.

Buse, Hamerly, Miranda, Svea, and Tonka are the principal minor soils in this association. The well drained Buse soils are on knolls. They have a subsoil that is calcareous throughout. The somewhat poorly drained Hamerly soils are on flats around depressions. They have an accumulation of lime within a depth of 16 inches. The somewhat poorly drained Miranda soils are on flats. They have salts within a depth of 16 inches. The moderately well drained Svea soils occur as areas intermingled with areas of the Cresbard soils. The poorly drained Tonka soils are in depressions.

Most areas are used for cultivated crops. The association is suited to cultivated crops and is well suited to hay, range, and pasture. The main concerns in managing cultivated areas are controlling water erosion and improving root penetration in the dense subsoil of the Cresbard and Cavour soils.

The main limitations affecting building sites are the shrink-swell potential and the seasonal high water table in the Cavour and Cresbard soils. The main limitations affecting septic tank absorption fields are slow permeability and the seasonal high water table in the Cavour and Cresbard soils.

6. Williams-Zahl Association

Deep, medium textured, level to very steep, well drained soils

This association is on flats, rises, knolls, and ridges on till plains and moraines. Slopes generally are medium in length and are smooth. A few drainageways and swales are throughout most areas. Slope ranges from 0 to 60 percent.

This association makes up about 5 percent of the county. It is about 64 percent Williams soils, 10 percent Zahl soils, and 26 percent soils of minor extent.

The level to hilly Williams soils are on the flats and rises. Typically, the surface layer is very dark brown loam about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam.

The gently rolling to very steep Zahl soils are on the knolls and ridges. Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark grayish brown loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown loam.

Arvilla, Niobell, and Stirum are the principal minor soils in this association. The Arvilla soils have a gravelly substratum. They are on rises. The moderately well drained Niobell soils are in swales. They have a dense, alkali subsoil. The poorly drained Stirum soils are in drainageways.

Most areas are used for cultivated crops; however, the steeper areas generally are used as range and pasture. This association is suited to cultivated crops and is well suited to hay, range, and pasture. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The main concern in managing range or pasture is maintaining an adequate

cover of the native or introduced forage plants.

The main limitations affecting building sites are the shrink-swell potential and slope. The main limitations affecting septic tank absorption fields are the moderately slow permeability and slope.

7. Williams-Zahl-Parnell Association

Deep, medium textured and moderately fine textured, level to hilly, well drained and very poorly drained soils

This association is on knolls, flats, rises, and ridges and in shallow depressions on till plains and moraines. The slopes generally are short and irregular. A few drainageways and deep depressions are throughout most areas. Slope ranges from 0 to 20 percent.

This association makes up about 1 percent of the county. It is about 41 percent Williams soils, 38 percent Zahl soils, 14 percent Parnell soils, and 7 percent soils of minor extent.

The undulating to hilly, well drained Williams soils are on the flats and rises. Typically, the surface layer is very dark brown loam about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam.

The gently rolling to hilly, well drained Zahl soils are on the knolls and ridges. Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark grayish brown loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown loam.

The level, very poorly drained Parnell soils are in shallow depressions. Typically, a 1-inch cover of undecomposed stems, leaves, and roots is at the surface. The surface soil is black silty clay loam about 13 inches thick. The subsoil is black silty clay about 31 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay.

Southam and Stirum are the principal minor soils in this association. The very poorly drained Southam soils are in deep depressions. They are calcareous throughout. The poorly drained Stirum soils are in drainageways. They have a dense, alkali subsoil.

Most areas are used for cultivated crops; however, the steeper areas generally are used as range. The association is poorly suited to cultivated crops, is suited to hay and pasture, and is well suited to range. The Parnell soils are well suited to wetland wildlife habitat. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The main concern in managing range is maintaining an adequate cover of the important forage plants.

The main limitations affecting building sites are the shrink-swell potential in the Williams and Zahl soils and ponding on the Parnell soils. The main limitations affecting septic tank absorption fields are the moderately slow permeability of the Williams and Zahl soils and ponding on the Parnell soils.

Level to Undulating, Sandy and Loamy Soils on Till Plains, Lacustrine Plains, and Delta Plains

These soils formed in glacial till, glaciofluvial deposits, and glaciolacustrine deposits. They make up about 12 percent of the county. Most areas are used for cultivated crops. The soils are poorly suited to cultivated crops, but they are well suited to hay, range, and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

8. Towner-Swenoda-Hecla Association

Deep, coarse textured and moderately coarse textured, level to undulating, moderately well drained soils

This association is on low ridges and flats and in swales on till plains, lacustrine plains, and delta plains. Slopes generally are long and smooth. A few drainageways and depressions are throughout most areas. Slope ranges from 0 to 6 percent.

This association makes up about 12 percent of the county. It is about 30 percent Towner soils, 25 percent Swenoda soils, 10 percent Hecla soils, and 35 percent soils of minor extent (fig. 5).

The level to undulating Towner soils are on the low ridges and flats. Typically, the surface soil is loamy fine sand about 19 inches thick. It is very dark gray in the upper part and very dark brown in the lower part. The subsoil is about 16 inches thick. It is dark brown. It is fine sand in the upper part and loam in the lower part. The next layer is brown loam about 10 inches thick. The substratum to a depth of about 60 inches is dark brown, mottled clay loam.

The level to undulating Swenoda soils are on the flats and in the swales. Typically, the surface soil is black fine sandy loam about 14 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The next layer is grayish brown, mottled silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled silty clay loam.

The level and nearly level Hecla soils are on the low ridges and in the swales. Typically, the surface soil is

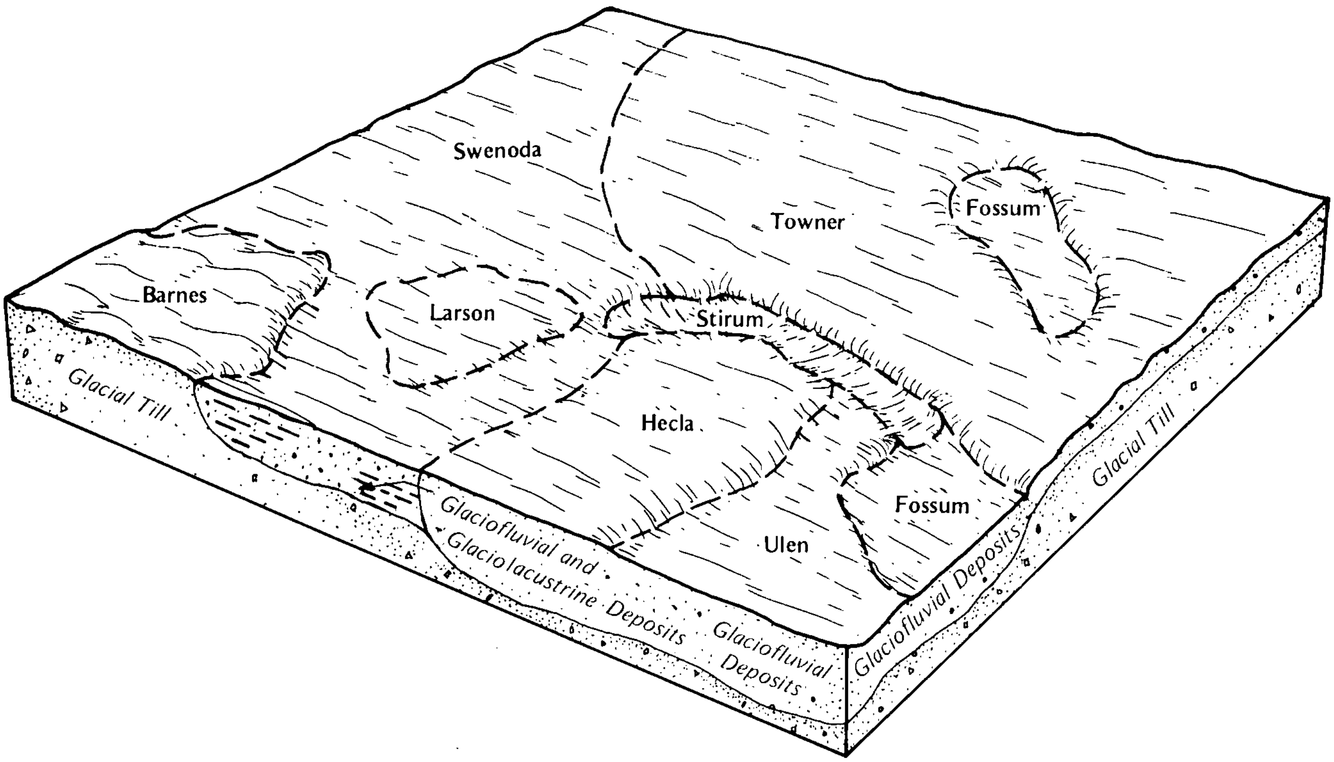

Figure 5.—Typical pattern of soils and parent material in the Towner-Swenoda-Hecla association.

about 15 inches thick. It is very dark gray. It is loamy fine sand in the upper part and fine sand in the lower part. The next layer is very dark grayish brown fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and light olive brown in the lower part.

Barnes, Fossum, Larson, Stirum, and Ulen soils are the minor soils in this association. The well drained Barnes soils are on rises. They have a loam surface layer and subsoil. The poorly drained Fossum soils are in depressions. The moderately well drained Larson soils have a dense, alkali subsoil. Areas of the Larson soils are intermingled with areas of the Swenoda soils. The poorly drained Stirum soils are in drainageways. They have a dense, alkali subsoil. The somewhat poorly drained Ulen soils are on flats adjacent to depressions and drainageways. They have an accumulation of lime within a depth of 16 inches.

Most areas are used for cultivated crops. The association is poorly suited to cultivated crops, but it is well suited to hay, range, and pasture. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness.

The main limitations affecting building sites are the seasonal high water table and caving in of walls in excavations for basements. The main limitation affecting septic tank absorption fields is possible pollution of ground water.

Level to Undulating, Loamy and Silty Soils on Lacustrine Plains

These soils formed in glaciolacustrine deposits. They make up about 7 percent of the county. Most areas are used for cultivated crops. The soils are well suited to cultivated crops, hay, range, and pasture. The main concern in managing cultivated crops is controlling soil blowing.

9. Embden-Wyndmere-Gardena Association

Deep, moderately coarse textured and medium textured, level and nearly level, moderately well drained and somewhat poorly drained soils

This association is on flats and in swales and slight depressions on lacustrine plains. Slopes generally are

long and smooth. A few deep depressions and rises are throughout most areas. Slope ranges from 0 to 3 percent.

This association makes up about 6 percent of the county. It is about 31 percent Embden and similar soils, 17 percent Wyndmere and similar soils, 11 percent Gardena and similar soils, and 41 percent soils of minor extent.

The level and nearly level, moderately well drained Embden soils are on the flats and in the swales. Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 31 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loamy fine sand.

The level, somewhat poorly drained Wyndmere soils are in the slight depressions. Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 30 inches thick. It is light brownish gray in the upper part and brown and mottled in the lower part. The substratum to a depth of about 60 inches is brown, mottled fine sandy loam in the upper part and light olive brown, mottled loamy fine sand in the lower part.

The level and nearly level, moderately well drained Gardena soils are on the flats and in the swales. Typically, the surface soil is loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 18 inches thick. It is very dark grayish brown loam in the upper part and dark brown very fine sandy loam in the lower part. The next layer is light brownish gray silt loam. The substratum to a depth of about 60 inches is light olive brown silt loam.

Colvin, Egeland, Glyndon, and Swenoda are the principal minor soils in this association. The poorly drained Colvin soils are in deep depressions. They are silt loam throughout. The well drained Egeland soils are on rises. The dark color of their surface layer extends to a depth of less than 16 inches. The somewhat poorly drained Glyndon soils are on flats and in shallow depressions. They have a layer of lime accumulation within a depth 16 inches. The moderately well drained Swenoda soils have a silty clay loam substratum within a depth of 40 inches. They occur as areas intermingled with areas of the Embden soils.

Most areas of this association are used for cultivated crops. The association is well suited to cultivated crops, hay, range, and pasture. The main concern in managing cultivated areas is controlling soil blowing. The main limitation affecting building sites and septic tank absorption fields is the seasonal high water table.

10. Great Bend-Egeland-Overly Association

Deep, moderately fine textured to moderately coarse textured, level to undulating, well drained and moderately well drained soils

This association is on rises, knolls, and flats and in swales on lacustrine plains. Slopes generally are long and smooth. A few depressions are throughout most areas. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 30 percent Great Bend soils, 22 percent Egeland soils, 17 percent Overly soils, and 31 percent soils of minor extent.

The level and nearly level, well drained Great Bend soils are on the flats and rises. Typically, the surface layer is black silty clay loam about 9 inches thick. The subsoil is about 12 inches thick. It is very dark grayish brown silty clay loam in the upper part and dark grayish brown silt loam in the lower part. The next layer is dark grayish brown silty clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay.

The level to undulating, well drained Egeland soils are on knolls. Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 11 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The next layer is brown fine sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is dark brown, stratified fine sandy loam and loam.

The level and nearly level, moderately well drained Overly soils are on the flats and in the swales. Typically, the black surface soil is about 11 inches thick. It is loam in the upper part and silt loam in the lower part. The subsoil is very dark gray silt loam about 14 inches thick. The next layer is brown silt loam about 6 inches thick. The substratum to a depth of about 60 inches is silt loam. It is light olive brown in the upper part and light olive brown and mottled in the lower part.

Aberdeen, Colvin, Fargo, and Glyndon are the principal minor soils in this association. The moderately well drained Aberdeen soils are on flats and in swales. They have a dense, alkali subsoil. The poorly drained Colvin soils are in depressions. They are silt loam throughout. The poorly drained Fargo soils are in shallow depressions. They have a silty clay surface layer and subsoil. The somewhat poorly drained

Glyndon soils are on flats around depressions. They have a layer of lime accumulation within a depth of 16 inches.

Most areas are used for cultivated crops. The association is well suited to cultivated crops, hay, range, and pasture. The major concerns in managing cultivated areas are controlling soil blowing on the Egeland soils and maintaining tilth and fertility. The main limitation affecting building sites and septic tank absorption fields is the seasonal high water table in the Overly soils.

Level to Undulating, Clayey, Loamy, and Silty Soils on Bottom Land and Terraces

These soils formed in alluvium. They make up about 5 percent of the county. Most areas are used for hay, range, or pasture, but some are used for cultivated crops and wetland wildlife habitat. The soils are suited to cultivated crops, hay, range, and pasture. The main concerns in managing cultivated areas are controlling soil blowing, overcoming wetness, and maintaining or improving tilth.

11. Ludden Association

Deep, fine textured, level, poorly drained and very poorly drained soils

This association is on bottom land. It is subject to flooding. The slopes are long and smooth. Oxbows are throughout the association. Slope is 0 to 1 percent.

This association makes up about 3 percent of the county. It is about 80 percent Ludden and similar soils and 20 percent soils of minor extent.

The Ludden soils are on flats. Typically, a 2-inch cover of undecomposed stems and roots is at the surface. The surface layer is black clay about 5 inches thick. The subsoil is mottled silty clay about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is black clay about 13 inches thick. Below this is very dark gray clay about 13 inches thick. The substratum to a depth of about 60 inches is dark olive gray clay.

Ryan soils and water are the minor components in this association. The poorly drained Ryan soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Ludden soils.

Most areas are used for hay or wetland wildlife habitat, but some are used as range, pasture, or cultivated crops. If drained, this association is suited to small grain, flax, and sunflowers. It is best suited to range, hay, and pasture. The main concerns in managing range are maintaining an adequate cover of the important forage plants and reducing compaction and shearing, which are caused by grazing when the soils are wet. The main concerns in managing cultivated areas are controlling flooding and improving tilth. In the northern part of the survey area, this association is permanently flooded by water control structures and is suited only to wetland wildlife habitat and esthetic uses. The main limitation affecting building sites and septic tank absorption fields is flooding.

12. Harriet-Ryan Association

Deep, medium textured, level, poorly drained, alkali soils

This association is on flats and in swales on bottom land. It is subject to flooding. The slopes are long and smooth. Slope is 0 to 1 percent.

This association makes up about 1 percent of the county. It is about 73 percent Harriet soils, 12 percent Ryan soils, and 15 percent soils of minor extent.

The Harriet soils are on flats. Typically, the surface layer is black silt loam about 1 inch thick. The subsoil is about 22 inches thick. It is black silty clay in the upper part and very dark gray clay loam in the lower part. The next layer is dark grayish brown, mottled clay loam about 12 inches thick. Below this is grayish brown, mottled fine sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loamy fine sand.

The Ryan soils are on flats and in swales. Typically, the surface layer is black loam about 1 inch thick. The subsoil is silty clay about 34 inches thick. It is black in the upper part, very dark gray in the next part, and dark gray in the lower part. The substratum to a depth of about 60 inches is olive, mottled silty clay loam.

Letcher and Stirum are the principal minor soils in this association. The moderately well drained Letcher soils are on low knolls. They have a fine sandy loam surface layer and subsoil and a loamy fine sand substratum. The poorly drained Stirum soils have a fine sandy loam surface layer and a fine sandy loam and very fine sandy loam subsoil. They occur as areas intermingled with areas of the Harriet soils.

Most areas of the association are used as range or hay. The association generally is unsuited to cultivated crops because of the dense, alkali subsoil and the salts. The main concerns in managing range are maintaining an adequate cover of the important salt-tolerant forage plants and preventing denuding. The main limitation affecting building sites and septic tank absorption fields is flooding.

13. Velva-LaDelle-Harriet Association

Deep, medium textured and moderately fine textured, level to undulating, well drained, moderately well drained, and poorly drained soils

This association is on flats and rises and in depressions on bottom land and terraces. It is subject to flooding. Slopes generally are long and smooth. A few oxbows are throughout most areas. Slope ranges from 0 to 6 percent.

This association makes up about 1 percent of the county. It is about 37 percent Velva soils, 16 percent LaDelle soils, 12 percent Harriet soils, and 35 percent soils of minor extent.

The level to undulating, well drained Velva soils are on the flats and rises. Typically, a cover of undecomposed stems, leaves, and roots is at the surface. The surface layer is very dark gray loam about 5 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown loam in the upper part, dark brown loam in the next part, and dark brown fine sandy loam in the lower part. The next layer is very dark grayish brown silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is dark brown loam.

The level and nearly level, moderately well drained LaDelle soils are on the flats. Typically, the surface soil is black silty clay loam about 20 inches thick. The subsoil is silty clay loam about 24 inches thick. It is very dark grayish brown and very dark gray in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam.

The level, poorly drained, alkali Harriet soils are in the shallow depressions. Typically, the surface layer is black silt loam about 1 inch thick. The subsoil is about 22 inches thick. It is black silty clay in the upper part and very dark gray clay loam in the lower part. The next layer is dark grayish brown, mottled clay loam about 12 inches thick. Below this is grayish brown, mottled fine sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loamy fine sand.

Ludden soils and water are the principal minor components in this association. The poorly drained and very poorly drained Ludden soils are in oxbows. They have a clay surface layer and substratum.

Most areas are used for cultivated crops, but a few are used for hay, range, or pasture. This association is well suited to cultivated crops, hay, range, and pasture. The main concerns in managing cultivated areas are controlling soil blowing and reducing the risk of flooding. The main concern in managing range or pasture is maintaining an adequate cover of the important native or introduced forage plants. The main limitation for building sites and septic tank absorption fields is flooding.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Williams loam, 0 to 3 percent slopes, is a phase of the Williams series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Falsen-Karlsruhe complex, 0 to 3 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Fossum and Arveson soils is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Some of the boundaries and soil names on the detailed soil maps of McHenry County do not match those on the detailed soil maps of Bottineau, Pierce, McLean, and Ward Counties. The differences are a result of improvements in the classification of soils, particularly in modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of soils within the survey area.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1—Tonka silt loam. This deep, level, poorly drained soil is in shallow depressions on till plains and lacustrine plains. It is subject to ponding. Individual

areas range from 3 acres to more than 15 acres in size.

Typically, the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray and dark gray, mottled silt loam about 5 inches thick. The subsoil is about 29 inches thick. It is very dark gray, mottled silty clay loam in the upper part, very dark gray silty clay loam in the next part, and olive gray, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In some places the soil does not have a subsurface layer. In other places it has an accumulation of lime within a depth of 16 inches.

Included with this soil in mapping are small areas of the very poorly drained Parnell soils in the deepest part of the depressions. The included soils make up about 5 percent of the unit.

Permeability is slow in the Tonka soil, and runoff is ponded. Available water capacity and the organic matter content are high. A seasonal high water table is 0.5 foot above to 1.0 foot below the surface. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, ponding frequently delays or prevents tillage, seeding, or harvest operations and crops are harvested in only 5 to 7 years out of 10. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. The soil and the ponded water provide habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used as range, the important range forage plants are slim sedge, wooly sedge, and prairie cordgrass. Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 39 to 84, depending on the degree of drainage. The range site is Wet Meadow.

2—Parnell silty clay loam. This deep, level, very poorly drained soil is in deep depressions on till plains and lacustrine plains. It is subject to ponding (fig. 6). Individual areas range from about 3 acres to more than 30 acres in size.

Typically, a 1-inch cover of undecomposed stems, leaves, and roots is at the surface. The surface soil is black silty clay loam about 13 inches thick. The subsoil is black silty clay about 31 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay. In some places the surface soil is silt loam. In other places an accumulation of lime is within a depth of 16 inches.

Included with this soil in mapping are small areas of the calcareous Southam soils in the deepest part of the depressions. The included soils make up about 10 percent of the unit.

Permeability is slow in the Parnell soil, and runoff is ponded. Available water capacity and the organic matter content are high. A seasonal high water table is 2 feet above to 2 feet below the surface. Tilth is fair.

Most areas are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding prevents or delays tillage, seeding, or harvesting. Crops are harvested in only 2 to 4 years out of 10. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. The soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used as range, the important forage plants are slough sedge and rivergrass. In drained areas, reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the

Figure 6.—Typical area of Parnell silty clay loam.

soil is wet. Grazing should be deferred while the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rate of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the slow permeability. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat ranges from 20 to 69, depending on the degree of drainage. The range site is Wetland.

5—Southam silt loam. This deep, level, very poorly drained soil is in deep depressions on till plains and lacustrine plains. It is subject to ponding. Individual areas range from about 3 acres to more than 130 acres in size.

Typically, the surface soil is about 36 inches thick. It is black silt loam in the upper part and very dark gray silty clay loam in the lower part. The substratum to a depth of about 60 inches is silty clay loam. It is dark gray in the upper part and very dark gray in the lower part.

Included with this soil in mapping are small areas of

water and small areas of Fossum soils. These soils have a fine sandy loam surface layer and fine sand substratum. The included soils and water make up about 5 percent of the unit.

Permeability is slow in the Southam soil, and runoff is ponded. Available water capacity is high. The organic matter content is very high. A seasonal high water table is 5 feet above to 1 foot below the surface.

Most areas are used for wetland wildlife habitat. This soil is best suited to this use. Because of the ponding, it generally is unsuited to cultivated crops, hay, pasture, and trees and shrubs. Locating suitable drainage outlets is very difficult. As a result, few areas are drained. The soil and ponded water provide excellent winter cover for resident wildlife and high quality feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

6—Rifle mucky peat. This deep, level, very poorly drained soil is in oxbows on elevated bottom land. It is subject to ponding. Individual areas range from about 40 acres to more than 800 acres in size.

Typically, the surface layer is black mucky peat about 6 inches thick. The substratum to a depth of about 60 inches is mucky peat. It is very dark brown in the upper part and black in the lower part. In places mineral soil is at a depth of 16 to 51 inches.

Included with this soil in mapping are small areas of water and some mineral soils. The included soils and water make up about 5 percent of the unit.

Permeability is rapid in the Rifle soil, and runoff is ponded. Available water capacity and the organic matter content are very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used for wildlife habitat. This soil is best suited to this use. Because of a high water table and low soil strength, it is generally unsuited to cultivated crops, hay, pasture, range, and trees and shrubs. The soil generally will not support livestock traffic; however, a few areas are slightly drier and may be used for pasture or hay in some years. This soil provides excellent winter cover and high quality feeding sites for resident wildlife.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table and the low soil strength. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

10—Aberdeen-Great Bend complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on lacustrine plains. The moderately well drained, alkali Aberdeen soil is in swales. The well drained Great Bend soil is on slight rises. Individual areas range from about 5 acres to more than 150 acres in size. They are about 45 to 65 percent Aberdeen soil and 25 to 40 percent Great Bend soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Aberdeen soil has a black silt loam surface layer about 5 inches thick. The next layer is very dark gray and very dark grayish brown silt loam about 5 inches thick. The subsoil is silty clay loam about 28 inches thick. It is dense and very dark grayish brown in the upper part, dark grayish brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is mottled silty clay. It is very dark grayish brown in the upper part and dark olive gray in the lower part.

Typically, the Great Bend soil has a black silty clay loam surface layer about 9 inches thick. The subsoil is about 12 inches thick. It is very dark grayish brown silty clay loam in the upper part and dark grayish brown silt loam in the lower part. The next layer is dark grayish brown silty clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Embden, Fargo, and Gardena soils. These included soils make up about 15 percent of the unit. The Embden and Gardena soils have less clay than the Great Bend soil, and they occur as areas intermingled with areas of the Aberdeen soil. The poorly drained Fargo soils are in depressions. Also included are a few areas of soils that have a very dense subsoil. These soils occur as areas intermingled with areas of the Aberdeen soil.

Permeability is slow in the Aberdeen soil and moderately slow in the Great Bend soil. Runoff is slow on both soils. Available water capacity is high in both soils. The organic matter content is high in the Aberdeen soil and moderate in the Great Bend soil. A seasonal high water table is at a depth of 4 to 6 feet in

the Aberdeen soil. Tilth is fair in both soils. The root zone in the Aberdeen soil is shallow because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is improving root penetration in the dense, alkali subsoil of the Aberdeen soil. Crops growing on this soil characteristically are stunted because of moisture stress. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Aberdeen soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and porcupinegrass. Intermediate and pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major limitations affect the use of these soils for range or pasture.

The Aberdeen soil is suited to many and the Great Bend soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs on the Aberdeen soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improves the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The Great Bend soil is better suited than the Aberdeen soil for these uses. The shrink-swell potential of the Aberdeen soil is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The moderately slow permeability in the Great Bend soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the absorption field. The seasonal high water table and slow permeability in the Aberdeen soil are limitations in absorption fields, but they can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the Aberdeen soil is IIIs, and that of the Great Bend soil is IIc. The productivity index of the unit for spring wheat is 83. The range site of the Aberdeen soil is Clayey, and that of the Great Bend soil is Silty.

17B—Arvilla sandy loam, 0 to 6 percent slopes. This deep, level to undulating, somewhat excessively drained soil is on flats and rises on outwash plains. Individual areas range from 3 acres to more than 300 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is sandy loam about 8 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is dark brown gravelly coarse sand. In some places the surface layer and subsoil are coarse sand or loam.

Included with this soil in mapping are small areas of excessively drained Sioux soils. These included soils make up about 15 percent of the unit. They have sand and gravel within a depth of 14 inches. They occur as areas intermingled with areas of the Arvilla soil.

Permeability is moderately rapid in the upper part of the Arvilla soil and very rapid in the lower part. Runoff is slow. Available water capacity is low. The organic matter content is moderate. Tilth is good. The root zone is shallow because of the gravelly coarse sand substratum.

Most areas are used for cultivated crops. Because of droughtiness, this soil is very poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, because these crops protect the surface against soil blowing in fall, winter, and spring and because they make the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity is low. Also, fallowing increases the risk of soil blowing.

In areas where this soil is used as range, the important range forage plants are needleandthread and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to some of the trees and shrubs grown as windbreaks and environmental plantings. It is droughty, however, and the trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is low. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 36. The range site is Shallow to Gravel.

18B—Aylmer-Bantry fine sands, 0 to 6 percent slopes. These deep, level to undulating soils are on delta plains. Slopes are short and choppy. The moderately well drained Aylmer soil is on rises. The somewhat poorly drained Bantry soil is in swales. Individual areas range from 20 acres to more than 3,000 acres in size. They are about 55 to 70 percent Aylmer soil and 20 to 40 percent Bantry soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Aylmer soil has a black fine sand surface layer about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. In sequence downward, it is dark grayish brown, dark grayish brown and mottled, black and mottled, and grayish brown and mottled. In places the dark color of the surface layer extends to a depth of more than 10 inches.

Typically, the Bantry soil has a black, mottled fine sand surface layer about 4 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and dark grayish brown in the lower part. In places the dark color of the surface layer extends to a depth of more than 10 inches.

Included with these soils in mapping are small areas of Fossum and Serden soils. These included soils make up about 5 percent of the unit. The poorly drained Fossum soils are in depressions. The excessively drained Serden soils are on knolls and ridges.

Permeability is rapid in the Aylmer and Bantry soils, and runoff is slow. Available water capacity is low in both soils. The organic matter content is low in the Aylmer soil and moderately low in the Bantry soil. A seasonal high water table is at a depth of 1.5 to 3.5 feet in the Aylmer soil and at 1 foot to 2 feet in the Bantry soil.

Most areas are used for hay, range, or pasture. Because of droughtiness and the severe hazard of soil blowing, these soils generally are unsuited to cultivated crops. The important range forage plants are prairie sandreed, needleandthread, and switchgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding. It also provides plant cover for rangeland wildlife and permits regrowth of browse plants. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

The Aylmer soil generally is unsuited to trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted if special treatment, such as hand planting or scalp planting, is applied. The Bantry soil is suited to all of the climatically adapted species. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and are poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, these soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of both soils is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Aylmer soil is Sands, and that of the Bantry soil is Subirrigated Sands.

19B—Aylmer-Minnewaukan complex, 0 to 6 percent slopes. These deep soils are on delta plains. Slopes are short and choppy. The moderately well drained, level to undulating Aylmer soil is on rises. The poorly drained, level Minnewaukan soil is in depressions. Individual areas range from about 3 acres to more than 150 acres in size. They are about 50 to 80 percent Aylmer soil and 20 to 40 percent Minnewaukan soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Aylmer soil has a black fine sand surface layer about 3 inches thick. The substratum to a depth of about 60 inches is fine sand. In sequence downward, it is dark grayish brown, dark grayish brown and mottled, black and mottled, and grayish brown and mottled. In some places the surface layer is mottled. In other places the dark color of the surface layer extends to a depth of more than 10 inches.

Typically, the Minnewaukan soil has a black loamy fine sand surface layer about 3 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is olive in the upper part, gray in the next part, and light olive brown in the lower part. In some areas the subsoil has an accumulation of lime within a depth of 16 inches. In places the dark color of the surface layer extends to a depth of more than 10 inches.

Included with these soils in mapping are small areas of Maddock and Serden soils. These included soils make up about 5 percent of the unit. They are on knolls and ridges. The Maddock soils are well drained, and the Serden soils are excessively drained. Also included are some rolling areas.

Permeability is rapid in the Aylmer and Minnewaukan soils. Runoff is slow on the Aylmer soil and very slow on the Minnewaukan soil. Available water capacity is low in both soils. The organic matter content is low in the Aylmer soil and moderate in the Minnewaukan soil. A seasonal high water table is at a depth of 1.5 to 3.5 feet in the Aylmer soil and at the surface to 2.5 feet below the surface in the Minnewaukan soil.

Most areas are used for hay, range, or pasture. Because of droughtiness, wetness, slope, and the severe hazard of soil blowing, these soils generally are unsuited to cultivated crops. The important range forage plants are prairie sandreed, needleandthread, switchgrass, and big bluestem. Intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding. It also provides plant cover for rangeland wildlife and permits regrowth of browse plants. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

If drained, the Minnewaukan soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The undrained areas generally are unsuited. The Aylmer soil generally is unsuited to trees and shrubs. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Minnewaukan soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

The Aylmer soil is suited to buildings but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow

excavations, such as those of basements, tend to cave in unless they are shored.

The Minnewaukan soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table and the rapid permeability. Better sites generally are nearby.

The land capability classification of the Aylmer soil is VIe, and that of the Minnewaukan soil is IVs. The productivity index of the unit for spring wheat is 0. The range site of the Aylmer soil is Sands, and that of the Minnewaukan soil is Subirrigated.

24B—Barnes-Buse loams, 3 to 6 percent slopes. These deep, undulating, well drained soils are on till plains. The Barnes soil is on side slopes. The Buse soil is on knolls and shoulder slopes. Individual areas range from 5 acres to more than 300 acres in size. They are 60 to 70 percent Barnes soil and 25 to 35 percent Buse soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 5 inches. In other places the surface layer is very dark brown.

Included with these soils in mapping are small areas of Hamerly and Tonka soils. These included soils make up about 5 percent of the unit. The Hamerly soils are somewhat poorly drained and are around depressions. The Tonka soils are poorly drained and are in shallow depressions.

Permeability is moderately slow in the Barnes and Buse soils, and runoff is medium. Available water capacity is high. The organic matter content is high in the Barnes soil and moderate in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. Using a system of conservation tillage that leaves crop residue on the surface, providing field windbreaks, installing grassed waterways in areas where runoff concentrates, and stripcropping help to prevent excessive soil loss. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs on the Buse soil helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Barnes soil is IIe, and that of the Buse soil is IIIe. The productivity index of the unit for spring wheat is 67. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

24C—Barnes-Buse loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on till plains. The Barnes soil is on side slopes. The Buse soil is on knolls, ridges, and shoulder slopes. Individual areas range from 5 acres to more than 200 acres in size. They are 55 to 65 percent Barnes soil and 35 to 40 percent Buse soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 5 inches. In other places the surface layer is very dark brown.

Included with these soils in mapping are small areas of Hamerly and Tonka soils. These included soils make up about 5 percent of the unit. The Hamerly soils are somewhat poorly drained and are around depressions. The Tonka soils are poorly drained and are in shallow depressions.

Permeability is moderately slow in the Barnes and Buse soils, and runoff is medium. Available water capacity is high. The organic matter content is high in the Barnes soil and moderate in the Buse soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and flax. The main concern in managing cultivated areas is controlling water erosion and soil blowing. The hazard of soil blowing is slight on the Barnes soil and moderate on the Buse soil. The hazard of water erosion is moderate on both soils. Using a system of conservation tillage that includes leaving crop residue on the surface; providing buffer strips, such as strips of flax; providing field windbreaks; installing grassed waterways in areas where runoff concentrates; and stripcropping help to control water erosion and soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Barnes soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Buse soil is suited to only the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs on the Buse soil helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation for building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Barnes soil is IIIe, and that of the Buse soil is IVe. The productivity index of the unit for spring wheat is 50. The range site of the Barnes soil is Silty, and that of the Buse soil is Thin Upland.

24D—Buse-Barnes loams, 9 to 15 percent slopes. These deep, rolling, well drained soils are on dissected till plains and on moraines. The Buse soil is on shoulder slopes and summits. The Barnes soil is on side slopes. Individual areas range from 5 acres to more than 125 acres in size. They are 45 to 60 percent Buse soil and 35 to 50 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 5 inches. In other places the surface layer is very dark brown.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas

of the moderately well drained Swenoda soils on foot slopes. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Buse and Barnes soils, and runoff is rapid. Available water capacity is high. The organic matter content is moderate in the Buse soil and high in the Barnes soil. Tilth is good in both soils.

Most areas are used for cultivated crops. Because of slope and the severe hazard of water erosion, these soils generally are unsuited to small grain and flax. They are best suited to hay, range, and pasture. The important range forage plants are needleandthread, western wheatgrass, and green needlegrass. Intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Buse soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely on this soil. The Barnes soil is suited to nearly all of the climatically adapted species. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The slope is a limitation affecting both uses, but it can be overcome by designing absorption fields and buildings so that they conform to the natural slope of the land.

The land capability classification of the Buse soil is VIe, and that of the Barnes soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty.

24E—Buse-Barnes loams, 15 to 25 percent slopes. These deep, hilly, well drained soils are on dissected till plains and on moraines. The Buse soil is on shoulder slopes and summits. The Barnes soil is on side slopes. Individual areas range from 5 acres to more than 200 acres in size. They are about 40 to 65 percent Buse soil and 35 to 60 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 to 5 inches. In other places the surface layer is very dark brown.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with these soils in mapping are small areas of Sioux and Swenoda soils. These included soils make up about 10 percent of the unit. The Sioux soils have a gravelly substratum. They occur as areas intermingled with areas of the Buse soil. The Swenoda soils have a fine sandy loam surface layer and upper part of the subsoil. They are on foot slopes.

Permeability is moderately slow in the Buse and Barnes soils, and runoff is rapid. Available water capacity is high in both soils. The organic matter content is moderate in the Buse soil and high in the Barnes soil.

Most areas are used for hay, range, or pasture. Because of the slope, the moderate hazard of soil blowing on the Buse soil, and the severe hazard of water erosion on both soils, these soils generally are unsuited to cultivated crops. The important range forage plants are needleandthread, western wheatgrass, and green needlegrass. Intermediate wheatgrass, pubescent wheatgrass, Russian wildrye, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails.

Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted if special treatment, such as hand or scalp planting, is applied.

Because of the slope, these soils generally are not used as building sites or septic tank absorption fields.

The land capability classification of the Buse soil is VIIe, and that of the Barnes soil is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Buse soil is Thin Upland, and that of the Barnes soil is Silty.

29—Svea-Barnes loams, 0 to 2 percent slopes. These deep, level and nearly level soils are on till plains. The moderately well drained Svea soil is in swales. The well drained Barnes soil is on flats and rises. Individual areas range from 10 acres to more than 150 acres in size. They are about 45 to 65 percent Svea soil and 25 to 45 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Svea soil has a black loam surface layer about 9 inches thick. The subsoil is about 23 inches thick. It is very dark gray loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The next layer is light olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of only 4 to 6 inches.

Included with these soils in mapping are small areas of the Cresbard, Hamerly, and Tonka soils. These included soils make up about 10 percent of the unit. The Cresbard soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Svea soil. The Hamerly soils are somewhat poorly drained and are around depressions. The Tonka soils are poorly drained and are in shallow depressions.

Permeability is moderately slow in the Svea and Barnes soils, and runoff is slow. Available water capacity and the organic matter content are high in both soils. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is maintaining or improving fertility and tilth. One suitable practice is adding organic material to the surface layer. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are big bluestem, porcupinegrass, and green needlegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Svea soil is suited to all and the Barnes soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soils have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements on the Svea soil. The moderately slow permeability in the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The seasonal high water table and moderately slow permeability in the Svea soil are limitations, but they can be overcome by using a mound system.

The land capability classification of both soils is IIc. The productivity index of the unit for spring wheat is 88. The range site of the Svea soil is Overflow, and that of the Barnes soil is Silty.

29B—Barnes-Svea loams, 2 to 5 percent slopes. These deep, nearly level and undulating soils are on till plains. The well drained Barnes soil is on flats and rises. The moderately well drained Svea soil is in swales. Individual areas range from 20 acres to more than 3,000 acres in size. They are 55 to 60 percent Barnes soil and 25 to 35 percent Svea soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface

layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In places the dark color of the surface layer extends to a depth of only 4 to 6 inches.

Typically, the Svea soil has a black loam surface layer about 9 inches thick. The subsoil is about 23 inches thick. It is very dark gray loam in the upper part and dark grayish brown, mottled clay loam in the lower part. The next layer is light olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with these soils in mapping are small areas of the Hamerly, Parnell, and Tonka soils. These included soils make up about 10 percent of the unit. The Hamerly soils are somewhat poorly drained and are around depressions. The Parnell soils are very poorly drained and are in the deeper part of depressions. The Tonka soils are poorly drained and are in the shallower part of depressions.

Permeability is moderately slow in the Barnes and Svea soils. Runoff is medium on the Barnes soil and slow on the Svea soil. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet in the Svea soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling water erosion. The hazard of soil blowing is slight, and that of water erosion is moderate. Using a system of conservation tillage that leaves crop residue on the surface, installing grassed waterways in areas where runoff concentrates, and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, Russian wildrye, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all and the Svea soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soils have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements on the Svea soil. The moderately slow permeability in the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and seasonal high water table in the Svea soil are limitations, but they can be overcome by using a mound system.

The land capability classification of both soils is IIe. The productivity index of the unit for spring wheat is 81. The range site of both soils is Silty.

36—Miranda-Cavour loams. These deep, level, alkali soils are on till plains. The somewhat poorly drained Miranda soil is on flats. The moderately well drained Cavour soil is on rises. Individual areas range from 5 acres to more than 125 acres in size. They are 45 to 60 percent Miranda soil and 35 to 55 percent Cavour soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Miranda soil has a very dark gray loam surface layer about 3 inches thick. The subsoil is about 53 inches thick. It is very dark gray, very dense clay loam in the upper part; olive brown, mottled clay loam in the next part; and dark grayish brown, mottled sandy clay loam in the lower part. The substratum to a depth of about 60 inches is dark grayish brown, mottled loam. In some areas the subsoil has an accumulation of lime within a depth of 16 inches.

Typically, the Cavour soil has a black loam surface layer about 7 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is dense clay loam about 18 inches thick. It is very dark gray in the upper part, dark grayish brown in the next part, and olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is light olive brown in the upper part and dark gray in the lower part. In places the subsoil is less dense.

Included with these soils in mapping are small areas of the Parnell and Tonka soils. These included soils make up about 5 percent of the unit. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions.

Permeability is very slow in the Miranda and Cavour

soils, and runoff is slow. Available water capacity is moderate in both soils. The organic matter content is moderately low in the Miranda soil and moderate in the Cavour soil. The salts in the Miranda soil reduce the amount of water available to plants. A seasonal high water table is at a depth of 2 to 4 feet in the Miranda soil and at a depth of 4 to 6 feet in the Cavour soil. Tilth is poor in both soils. Because of the dense, alkali subsoil, the root zone is very shallow in the Miranda soil and shallow in the Cavour soil.

Most areas are used for cultivated crops. Because of the dense, alkali subsoil and the salts, these soils generally are unsuited to cultivated crops. They are best suited to hay, range, and pasture.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and blue grama. Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, alkali subsoil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in the Miranda soil sometimes contain salty water.

The Miranda soil generally is unsuited to the trees and shrubs grown as windbreaks and environmental plantings. The Cavour soil is suited to only a few of the drought- and salt-tolerant species. Supplemental watering and control of weedy ground cover help to ensure the survival of the seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and by the limited available water capacity caused by the salts in the soil.

These soils are very poorly suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The very slow permeability and seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification of the Miranda soil is VIs, and that of the Cavour soil is IVs. The productivity index of the unit for spring wheat is 0. The range site of the Miranda soil is Thin Claypan, and that of the Cavour soil is Claypan.

37—Cavour-Cresbard loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained, alkali soils are on till plains. The Cavour soil is in swales, and the Cresbard soil is on rises. Individual areas range from 10 acres to more than 200 acres in size. They are 40 to 50 percent Cavour soil and 35 to 45 percent Cresbard soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Cavour soil has a black loam surface layer about 7 inches thick. The subsurface layer is very dark gray loam about 3 inches thick. The subsoil is dense clay loam about 18 inches thick. It is very dark gray in the upper part, dark grayish brown in the next part, and olive brown in the lower part. The substratum to a depth of about 60 inches is mottled clay loam. It is light olive brown in the upper part and dark gray in the lower part.

Typically, the Cresbard soil has a black loam surface layer about 8 inches thick. The next layer is very dark brown and very dark grayish brown loam about 3 inches thick. The subsoil is about 12 inches thick. It is dense, dark brown clay loam in the upper part and olive brown loam in the lower part. The next layer is olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Included with these soils in mapping are small areas of the Hamerly, Miranda, Parnell, and Tonka soils. These included soils make up about 15 percent of the unit. The somewhat poorly drained Hamerly and Miranda soils are on flats around depressions. The Hamerly soils are saline. The Miranda soils have salts within 16 inches of the surface. The Parnell soils are very poorly drained and are in deep depressions. The Tonka soils are poorly drained and are in shallow depressions.

Permeability is very slow in the Cavour soil and slow in the Cresbard soil. Runoff is slow on both soils. Available water capacity and the organic matter content are moderate. A seasonal high water table is at a depth of 4 to 6 feet in both soils. Tilth is poor in the Cavour soil and fair in the Cresbard soil. Because of the dense, alkali subsoil, the root zone is shallow in both soils.

Most areas are used for cultivated crops. Because of the dense, alkali subsoil, these soils are poorly suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is improving root penetration. Crops growing on these soils characteristically are stunted because of moisture stress. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Growing deep

rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, green needlegrass, and blue grama. Intermediate wheatgrass, western wheatgrass, alfalfa, and sweetclover are suitable hay and pasture plants. The dense, alkali subsoil of the Cavour soil, which restricts the penetration of roots, and the salts, which reduce the amount of water available to plants, are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to improve root penetration.

The Cavour soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Cresbard soil is suited to many of the climatically adapted species. Supplemental watering and control of weedy ground cover help to ensure the survival of the seedlings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil.

The Cavour soil is poorly suited to buildings and septic tank absorption fields, but the Cresbard soil is suited to these uses. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The very slow and slow permeability and seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification of the Cavour soil is IVs, and that of the Cresbard soil is IIIs. The productivity index of the unit for spring wheat is 45. The range site of the Cavour soil is Claypan, and that of the Cresbard soil is Clayey.

44B—Claire-Lohnes coarse sands, 1 to 6 percent slopes, hummocky. These deep, nearly level and undulating soils are on windblown outwash plains and delta plains. Slopes are short and choppy. The excessively drained Claire soil is on knolls and ridges. The well drained Lohnes soil is in swales. Individual areas range from 5 acres to more than 120 acres in size. They are 40 to 70 percent Claire soil and 15 to 50 percent Lohnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Claire soil has a very dark gray coarse sand surface layer about 9 inches thick. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and brown in the lower part.

Typically, the Lohnes soil has a black coarse sand surface soil about 11 inches thick. The subsoil is coarse sand about 17 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and dark yellowish brown in the lower part.

Included with these soils in mapping are small areas of the Falsen, Karlsruhe, and Verendrye soils. These included soils make up about 15 percent of the unit. The Falsen soils are moderately well drained. They occur as areas intermingled with areas of the Lohnes soil. The Karlsruhe soils are somewhat poorly drained and are on flats around depressions. The Verendrye soils are poorly drained and are in depressions.

Permeability is rapid in the Claire and Lohnes soils, and runoff is very slow. Available water capacity is low. The organic matter content is moderately low.

Most areas are used for hay, range, or pasture. Because of droughtiness and the severe hazard of soil blowing, these soils generally are unsuited to cultivated crops. The important range forage plants are prairie sandreed and needleandthread. Intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be controlled by using a planned grazing system that controls the pattern of livestock traffic.

The Lohnes soil is suited to only a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is droughty, and the trees and shrubs growing on it commonly are affected by moisture stress. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is very low. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates

of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion. The Claire soil generally is unsuited to windbreaks and environmental plantings.

These soils are well suited to buildings but are poorly suited to septic tank absorption fields. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of both soils is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Claire soil is Thin Sands, and that of the Lohnes soil is Sands.

50—Colvin silt loam. This deep, level, poorly drained, highly calcareous soil is in shallow depressions and drainageways on lacustrine plains and till plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface soil is black silt loam about 10 inches thick. The subsoil is silt loam about 28 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled silt loam.

Included with this soil in mapping are small areas of the Arveson, Fossum, Marysland, and Tonka soils. These included soils make up about 20 percent of the unit. They occur as areas intermingled with areas of the Colvin soil. The Arveson and Fossum soils have more sand throughout than the Colvin soil. The Marysland soils have a coarse sand substratum. The Tonka soils have an accumulation of clay in the subsoil.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. Available water capacity and the organic matter content are high. A seasonal high water table is within a depth of 1 foot. Tilth is good.

Most areas are used as range, pasture, or hay. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, wetness sometimes delays or prevents tillage, seeding, or harvesting. The hazard of soil blowing is moderate, and that of water erosion is slight. In drained areas, using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and planting field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are slim sedge and wooly sedge. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table and the moderately slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 38 to 69, depending on the degree of drainage. The range site is Wet Meadow.

51—Colvin silt loam, saline. This deep, level, poorly drained, highly calcareous, moderately saline soil is on flats and in drainageways on lacustrine plains and till plains. Individual areas range from 5 acres to more than 200 acres in size.

Typically, the surface soil is black silt loam about 10 inches thick. It has an accumulation of salts. The subsoil is silt loam about 28 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled silt loam. In some places the subsoil is olive brown or dark brown. In other places a layer of lime accumulation is below a depth of 16 inches.

Included with this soil in mapping are small areas of the Harriet and Stirum soils. These included soils make up about 5 percent of the unit. They have a dense, alkali subsoil. The two soils occur as areas intermingled with areas of the Colvin soil.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. Available water capacity is

moderate. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is within a depth of 2 feet. Tilth is good.

Most areas are used as range, pasture, or hay. If drained, this soil is poorly suited to small grain, flax, and sunflowers because of salinity. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, wetness sometimes delays or prevents tillage, seeding, or harvesting. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and planting field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. A permanent cover of crops helps to control the accumulation of salts in the surface soil by reducing the evaporation rate at the surface.

In areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Alkali sacaton and sweetclover are suitable hay or pasture plants. The high content of salts and the limited available water capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table and moderately slow permeability. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 26 to 45, depending on the degree of drainage. The range site is Saline Lowland.

52—Colvin silt loam, wet. This deep, level, very poorly drained, highly calcareous soil is in depressions on till plains and lacustrine plains. It is subject to ponding. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface soil is black silt loam about 10 inches thick. The subsoil is silt loam about 28 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled silt loam. In places the subsoil does not have an accumulation of lime within a depth of 16 inches.

Included with this soil in mapping are small areas of water and small areas of the Southam soils. These soils and water make up about 5 percent of the unit. The Southam soils have a silty clay loam substratum. They occur as areas intermingled with areas of the Colvin soil.

Permeability is moderately slow in the Colvin soil, and runoff is ponded. Available water capacity and the organic matter content are high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used for hay, range, or wetland wildlife habitat. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets is difficult. As a result, few areas are drained. In undrained areas, ponding prevents or delays tillage, seeding, or harvesting. Crops are harvested in only 2 to 4 years out of 10. The hazard of soil blowing is moderate, and that of water erosion is slight. Soil blowing can be controlled by planting windbreaks and using a system of conservation tillage that leaves crop residue on the surface. The soil and the ponded water provide feeding, breeding, and rearing areas for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used as range, the important forage plants are slough sedge and rivergrass. If drained, reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred while the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling the regrowth of this cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic

tank absorption fields because of the ponding. Better sites generally are nearby.

The land capability classification is IIIw. The productivity index for spring wheat is 10 to 65, depending on the degree of drainage. The range site is Wetland.

54—Barnes-Cresbard loams, 0 to 3 percent slopes. These deep, level and nearly level soils are on till plains. The well drained Barnes soil is on flats. The moderately well drained, alkali Cresbard soil is in swales. Individual areas range from 10 acres to more than 500 acres in size. They are 45 to 55 percent Barnes soil and 40 to 50 percent Cresbard soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places it extends to a depth of only 4 to 6 inches.

Typically, the Cresbard soil has a black loam surface layer about 8 inches thick. The next layer is very dark brown and very dark grayish brown loam about 3 inches thick. The subsoil is about 12 inches thick. It is dense, dark brown clay loam in the upper part and olive brown loam in the lower part. The next layer is olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Included with these soils in mapping are small areas of the Cavour, Hamerly, Parnell, and Tonka soils. These included soils make up about 5 percent of the unit. The Cavour soils have a very dense subsoil. They occur as areas intermingled with areas of the Cresbard soil. The somewhat poorly drained Hamerly soils are in areas surrounding the depressions. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions.

Permeability is moderately slow in the Barnes soil and slow in the Cresbard soil. Runoff is medium on the Barnes soil and slow on the Cresbard soil. Available water capacity is high in the Barnes soil and moderate in the Cresbard soil. The organic matter content is high in the Barnes soil and moderate in the Cresbard soil. A seasonal high water table is at a depth of 4 to 6 feet in the Cresbard soil. Tilth is good in the Barnes soil and fair in the Cresbard soil. The root zone is shallow in the Cresbard soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is improving the penetration of roots in the dense, alkali subsoil of the Cresbard soil. Crops growing on the Cresbard soil characteristically are stunted because of moisture stress. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Cresbard soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and porcupinegrass. Pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Barnes soil is suited to nearly all and the Cresbard soil to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs grown on the Cresbard soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The Barnes soil is better suited than the Cresbard soil. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements on the Cresbard soil. The moderately slow permeability in the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and the seasonal high water table in the Cresbard soil are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification of the Barnes soil is IIc, and that of the Cresbard soil is IIIs. The productivity

index of the unit for spring wheat is 78. The range site of the Barnes soil is Silty, and that of the Cresbard soil is Clayey.

54B—Barnes-Cresbard loams, 3 to 6 percent slopes. These deep, undulating soils are on till plains. The well drained Barnes soil is on rises. The moderately well drained, alkali Cresbard soil is in swales. Individual areas range from 10 acres to more than 300 acres in size. They are 45 to 55 percent Barnes soil and 30 to 40 percent Cresbard soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places it extends to a depth of only 4 to 6 inches.

Typically, the Cresbard soil has a black loam surface layer about 8 inches thick. The next layer is dark brown and very dark grayish brown loam about 3 inches thick. The subsoil is about 12 inches thick. It is dense, dark brown clay loam in the upper part and olive brown loam in the lower part. The next layer is olive brown, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is olive brown, mottled loam.

Included with these soils in mapping are small areas of the Cavour, Hamerly, Parnell, and Tonka soils. These included soils make up about 10 percent of the unit. The Cavour soils have a very dense subsoil. They occur as areas intermingled with areas of the Cresbard soil. The somewhat poorly drained Hamerly soils are in areas around depressions. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in shallow depressions.

Permeability is moderately slow in the Barnes soil and slow in the Cresbard soil. Runoff is medium on both soils. Available water capacity is high in the Barnes soil and moderate in the Cresbard soil. The organic matter content is high in the Barnes soil and moderate in the Cresbard soil. A seasonal high water table is at a depth of 4 to 6 feet in the Cresbard soil. Tilth is good in the Barnes soil and fair in the Cresbard soil. The root zone is shallow in the Cresbard soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion and improving the penetration of roots in the dense, alkali subsoil of the Cresbard soil. Crops growing on the Cresbard soil characteristically are stunted because of moisture stress. The hazard of soil blowing is slight, and that of water erosion is moderate. Using a system of conservation tillage that includes leaving crop residue on the surface, installing grassed waterways in areas where runoff concentrates, and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Cresbard soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and porcupinegrass. Pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Barnes soil is suited to nearly all and the Cresbard soil to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs grown on the Cresbard soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The Barnes soil is better suited than the Cresbard soil. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements on the Cresbard soil. The moderately slow permeability in the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and the seasonal high water table in the Cresbard soil are limitations, but they can be overcome by using a mound system.

The land capability classification of the Barnes soil is IIe, and that of the Cresbard soil is IIIe. The productivity

index of the unit for spring wheat is 70. The range site of the Barnes soil is Silty, and that of the Cresbard soil is Clayey.

56—Divide loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on outwash plains. Individual areas range from 3 acres to more than 80 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsoil is about 16 inches thick. It is dark gray and gray loam in the upper part, dark gray loam in the next part, and dark grayish brown gravelly loam in the lower part. The substratum to a depth of about 60 inches is brown gravelly coarse sand. In places the surface layer and subsoil are sandy loam.

Included with this soil in mapping are small areas of the Karlsruhe, Marysland, and Wyndmere soils. These included soils make up about 15 percent of the unit. The Karlsruhe and Wyndmere soils have a surface layer and subsoil that contain more sand and less clay than those of the Divide soil. These soils occur as areas intermingled with areas of the Divide soil. The Marysland soils are poorly drained and are in depressions.

Permeability is moderate in the upper part of the Divide soil and very rapid in the lower part. Runoff is slow. Available water capacity is moderate. The organic matter content is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good. The root zone is moderately deep because of the gravelly coarse sand substratum.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. It is best suited to rye and winter wheat. These two crops protect the surface against soil blowing in fall, winter, and spring, and they make the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness in the latter part of the growing season. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; stripcropping; providing annual buffer strips, such as strips of flax; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the very rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 63. The range site is Limy Subirrigated.

62B—Egeland fine sandy loam, 0 to 6 percent slopes. This deep, level to undulating, well drained soil is on rises and flats on lacustrine plains. Individual areas range from 5 acres to more than 400 acres in size.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 11 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The next layer is brown fine sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is dark brown, stratified fine sandy loam and loam. In places the dark color of the surface layer extends to a depth of more than 16 inches.

Included with this soil in mapping are small areas of the well drained Maddock soils. These included soils make up about 10 percent of the unit. They have a loamy fine sand subsoil and substratum. They occur as areas intermingled with areas of the Egeland soil.

Permeability is moderately rapid in the Egeland soil, and runoff is slow. Available water capacity and the organic matter content are moderate. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and that of water erosion is slight. The soil is somewhat droughty. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where this soil is used as range, the important forage plants are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, however, and the trees and shrubs growing on it commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is moderate. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is well suited to buildings and septic tank absorption fields. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 58. The range site is Sandy.

65—Embden fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats and in swales on lacustrine plains. Individual areas range from 10 acres to more than 400 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is fine sandy loam about 31 inches thick. It is very dark grayish brown in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loamy fine sand. In some places the dark color of the surface layer extends to a depth of more than 8 inches to 15 inches. In other places the substratum is loam or silt loam.

Included with this soil in mapping are small areas of the Glyndon, Hecla, Maddock, and Wyndmere soils. These included soils make up about 10 percent of the unit. The somewhat poorly drained Glyndon and Wyndmere soils are in swales and around depressions. The Hecla soils contain more sand than the Embden soil. They occur as areas intermingled with areas of the Embden soil. The well drained Maddock soils are on knolls and low ridges.

Permeability is moderately rapid in the Embden soil, and runoff is slow. Available water capacity is moderate. The organic matter content is high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and that of water erosion is slight. The soil is slightly droughty. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where this soil is used as range, the important forage plants are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing.

This soil is suited to all of the climatically adapted

trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings and septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 74. The range site is Sandy.

68—Fargo silty clay. This deep, level, poorly drained soil is on flats on lacustrine plains. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface soil is about 11 inches thick. It is black. It is silty clay in the upper part and silty clay loam in the lower part. The subsoil is silty clay about 21 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled clay in the upper part and olive gray, mottled silty clay in the lower part. In places the surface soil and upper part of the subsoil are calcareous.

Included with this soil in mapping are small areas of very poorly drained soils in the deeper parts of depressions. These included soils make up about 5 percent of the unit.

Permeability is slow in the Fargo soil, and runoff is very slow. Available water capacity and the organic matter content are high. A seasonal high water table is within a depth of 3 feet. Tilth is poor.

Most areas are used for cultivated crops. If drained, this soil is suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. In undrained areas, tillage and seeding are delayed in the spring and occasionally until later in the growing season. This soil is best tilled only within a narrow range of moisture content because it is very sticky and tends to puddle when wet and is very hard and tends to become cloddy when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying over winter improve tilth of the surface layer and aid seedbed preparation; however, they also increase the susceptibility to soil blowing. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and planting field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, green needlegrass, and porcupinegrass. Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table, the shrink-swell potential, and the slow permeability. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 39 to 87, depending on the degree of drainage. The range site is Clayey.

72—Verendrye loamy coarse sand. This deep, level, poorly drained soil is on flats on outwash plains and delta plains. Individual areas range from 3 acres to more than 150 acres in size.

Typically, the surface soil is loamy coarse sand about 10 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark grayish brown and mottled in the upper part, olive gray and mottled in the next part, and light brownish gray in the lower part. In places a layer of lime accumulation is at a depth of 16 inches or less.

Included with this soil in mapping are small areas of the somewhat poorly drained Karlsruhe soils on flats and around depressions. These included soils make up about 5 percent of the unit.

Permeability is rapid in the Verendrye soil, and runoff is very slow. Available water capacity is very low. The organic matter content is high. A seasonal high water table is 1.0 foot to 2.5 feet below the surface. Tilth is fair.

Most areas are used as range, pasture, or hay. If drained, this soil is poorly suited to small grain, flax, and sunflowers because it is droughty. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, wetness frequently delays or prevents tillage, seeding, or harvesting. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that leaves crop residue on the surface, planting field windbreaks, and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem and switchgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table and the rapid permeability. Better sites generally are nearby.

The land capability classification is IVw. The productivity index for spring wheat ranges from 26 to 50, depending on the degree of drainage. The range site is Subirrigated.

73—Fossum and Arveson soils. These deep, level, poorly drained soils are on flats on outwash plains and delta plains. Individual areas range from 3 acres to more than 300 acres in size. They can consist entirely of Fossum soil, entirely of Arveson soil, or of any combination of both soils.

Typically, the Fossum soil has a black fine sandy loam surface soil about 13 inches thick. The next layer is very dark gray fine sand about 4 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is olive gray in the upper part and olive in the lower part. In some areas an accumulation of lime is within a depth of 16 inches.

Typically, the Arveson soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is dark gray loam about 21 inches thick. The next layer is very dark gray, mottled sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled sand.

Included with these soils in mapping are small areas of the very poorly drained Fossum soils and the Stirum, Ulen, and Wyndmere soils. These included soils make up about 10 percent of the unit. The very poorly drained Fossum soils are in the deeper parts of depressions. The Stirum soils have a dense, alkali subsoil. They occur as areas intermingled with areas of these Fossum and Arveson soils. The Ulen and Wyndmere soils are somewhat poorly drained and are on flats adjacent to depressions.

Permeability is rapid in the Fossum soil and moderately rapid in the Arveson soil. Runoff is very slow on both soils. Available water capacity is low in the Fossum soil and moderate in the Arveson soil. The organic matter content is high in both soils. A seasonal high water table is at a depth of 1.0 foot to 2.5 feet in the Fossum soil and at a depth of 1 foot to 2 feet in the Arveson soil. Tilth is good in both soils.

Most areas are used for hay, range, or pasture. If drained, these soils are suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, tillage, seeding, or harvest operations are sometimes delayed or prevented by wetness. The hazard of soil blowing is severe on the Fossum soil and moderate on the Arveson soil. The hazard of water erosion is slight on both soils. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are big bluestem and switchgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the

important or suitable plants helps to control soil blowing.

If drained, these soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on these soils are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils generally are unsuited to buildings and septic tank absorption fields because of the seasonal high water table and the rapid and moderately rapid permeability. Better sites generally are nearby.

The land capability classification of the Fossum soil is IIIw, and that of the Arveson soil is IIw. The productivity index of the unit for spring wheat ranges from 29 to 60, depending on the degree of drainage. The range site for both soils is Subirrigated.

74—Fossum fine sandy loam, wet. This deep, level, very poorly drained soil is in depressions on outwash plains and delta plains. It is subject to ponding. Individual areas range from 3 acres to more than 100 acres in size.

Typically, the surface soil is black fine sandy loam about 13 inches thick. The next layer is very dark gray fine sand about 4 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is olive gray in the upper part and olive in the lower part. In some places a layer of lime accumulation is within a depth of 16 inches.

Included with this soil in mapping are small areas of water. The water makes up about 10 percent of the unit.

Permeability is rapid in the Fossum soil, and runoff is ponded. Available water capacity is low. The organic matter content is high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used for wetland wildlife habitat or hay. Because of the ponded surface water and extent of the regional ground water table, this soil generally is very poorly suited to cultivated crops. It is best suited to hay and pasture. Locating suitable drainage outlets is difficult. As a result, few areas are drained. The hazard of soil blowing is severe, and that of water erosion is slight. Soil blowing can be controlled by planting windbreaks and using a system of conservation tillage that leaves crop residue on the surface. This soil and the ponded water provide feeding, breeding, and rearing sites for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where this soil is used as range, the important forage plants are slough sedge and rivergrass. If drained, reed canarygrass and creeping foxtail are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred while the soil is wet.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rate of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding. Better sites generally are nearby.

The land capability classification is IVw. The productivity index for spring wheat ranges from 20 to 40, depending on the degree of drainage. The range site is Wetland.

76—Gardena loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on lacustrine plains. Individual areas range from 10 acres to more than 150 acres in size.

Typically, the surface soil is loam about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 18 inches thick. It is very dark grayish brown loam in the upper part and dark brown very fine sandy loam in the lower part. The next layer is light brownish gray silt loam. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam. In places the dark color of the surface layer extends to a depth of only 8 inches to as much as 16 inches.

Included with this soil in mapping are small areas of the Embden, Glyndon, and Swenoda soils. These included soils make up about 10 percent of the unit. The Embden and Swenoda soils occur as areas intermingled with areas of the Gardena soil. Embden soils contain less silt and more sand than the Gardena

soil. The Swenoda soils have a substratum that contains more clay than that of the Gardena soil. The somewhat poorly drained Glyndon soils are in swales.

Permeability is moderate in the Gardena soil, and runoff is slow. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Soil blowing and water erosion are only slight hazards; however, soil blowing does occur during some storms. It can be controlled easily by using a system of conservation tillage that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are needleandthread, green needlegrass, and porcupinegrass. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of the ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings and septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation for septic tank absorption fields, but it can be overcome by using a mound system.

The land capability classification is IIe. The productivity index for spring wheat is 98. The range site is Silty.

79—Glyndon loam, saline. This deep, level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on lacustrine plains. Individual areas range from 5 acres to more than 150 acres in size.

Typically, the surface soil is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. It has an accumulation of salts. The subsoil is silt loam about 14 inches thick. It is dark gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam. In places the soil contains more clay throughout.

Included with this soil in mapping are small areas of the Colvin, Stirum, and Wyndmere soils. These included soils make up about 10 percent of the unit. The Colvin and Stirum soils are in depressions. The Colvin soils contain more clay than the Glyndon soil. The Stirum soils have a dense, alkali subsoil. The Wyndmere soils have a fine sandy loam surface layer and subsoil. They occur as areas intermingled with areas of the Glyndon soil.

Permeability is moderate in the Glyndon soil, and runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops. Because of the salinity, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to salt-tolerant crops, hay, pasture, and range. Maintaining a permanent cover of crops helps to control the accumulation of salts in the surface soil by reducing the evaporation rate at the surface. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Tall wheatgrass, alkali sacaton, and sweetclover are suitable hay and pasture plants. The high content of salts, soil blowing, and the limited available water capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable, salt-tolerant plants helps to control soil blowing and to leach salts from the root zone. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling

survival. When the bare surface dries, salt-laden water tends to move to the surface. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation for septic tank absorption fields, but it can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 59. The range site is Saline Lowland.

80—Glyndon loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats on lacustrine plains. Individual areas range from 5 acres to more than 250 acres in size.

Typically, the surface soil is loam about 12 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is silt loam about 14 inches thick. It is dark gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled silt loam. In places the soil contains more clay throughout.

Included with this soil in mapping are small areas of the Colvin and Gardena soils and the saline Glyndon soils. These included soils make up about 10 percent of the unit. The poorly drained Colvin soils are in depressions. The moderately well drained Gardena soils are on rises. The saline Glyndon soils have salts throughout the profile. They occur as areas intermingled with areas of this Glyndon soil.

Permeability is moderate in the Glyndon soil, and runoff is slow. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; stripcropping; providing annual buffer strips, such as strips of flax; and providing field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem, big bluestem, and switchgrass. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIe. The productivity index for spring wheat is 93. The range site is Limy Subirrigated.

82—Great Bend-Overly complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on lacustrine plains. The well drained Great Bend soil is on flats and rises. The moderately well drained Overly soil is in swales. Individual areas range from 5 acres to more than 100 acres in size. They are 45 to 70 percent Great Bend soil and 20 to 50 percent Overly soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Great Bend soil has a black silty clay loam surface layer about 9 inches thick. The subsoil is about 12 inches thick. It is very dark grayish brown silty clay loam in the upper part and dark grayish brown silt loam in the lower part. The next layer is dark grayish brown silty clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark grayish brown silty clay. In places slope is 3 to 6 percent.

Typically, the surface soil of the Overly soil is about 11 inches thick. It is black. It is loam in the upper part

and silt loam in the lower part. The subsoil is very dark gray silt loam about 14 inches thick. The next layer is brown silt loam about 6 inches thick. The substratum to a depth of 60 inches is light olive brown silt loam. It is mottled in the lower part.

Included with these soils in mapping are small areas of the Colvin and Glyndon soils. These included soils make up about 10 percent of the unit. The poorly drained Colvin soils are in depressions. The somewhat poorly drained Glyndon soils are in areas around depressions.

Permeability is moderately slow in the Great Bend and Overly soils, and runoff is slow. Available water capacity is high in both soils. The organic matter content is moderate in the Great Bend soil and high in the Overly soil. A seasonal high water table is at a depth of 4 to 6 feet in the Overly soil. Tilth is good in the Overly soil and fair in the Great Bend soil.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is maintaining or improving fertility and tilth. Fertility and tilth can be maintained or improved by adding organic material to the surface soil. Water erosion and soil blowing are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are western wheatgrass, porcupinegrass, and needleandthread. Intermediate wheatgrass, smooth bromegrass, switchgrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of these soils for range or pasture.

The Great Bend soil is suited to nearly all and the Overly soil to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soils have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

The Great Bend soil is well suited and the Overly soil is suited to buildings. Both soils are suited to septic tank absorption fields. The shrink-swell potential of the Overly soil is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The moderately slow permeability in the Great Bend soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and seasonal high water table in the Overly soil are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification is IIc for both soils. The productivity index of the unit for spring wheat is 91. The range site for both soils is Silty.

88—Hamerly loam, saline, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on till plains. Individual areas range from 5 acres to more than 90 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. It has an accumulation of salts. The subsoil is mottled loam about 26 inches thick. It is light brownish gray in the upper part and brown in the lower part. The substratum to a depth of about 60 inches is mottled loam. It is brown in the upper part and light olive brown in the lower part.

Included with this soil in mapping are small areas of the Miranda and Tonka soils and some poorly drained, highly calcareous, saline soils. These included soils make up about 20 percent of the unit. The Miranda soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Hamerly soil. The Tonka soils have a leached subsurface layer. They are in shallow depressions. The poorly drained saline soils occur as areas intermingled with areas of the Hamerly soil.

Permeability is moderately slow in the Hamerly soil, and runoff is slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. Because of salinity, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to salt-tolerant crops, hay, pasture, and range. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and

stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Tall wheatgrass and sweetclover are suitable hay or pasture plants. The high content of salts, soil blowing, and the limited available water capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings, but it is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The moderately slow permeability and seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification is IIIs. The productivity index for spring wheat is 49. The range site is Saline Lowland.

89—Hamerly loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on till plains. Individual areas range from 5 acres to more than 40 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsoil is mottled loam about 26 inches thick. It is light brownish gray in the upper part and brown in the lower part. The substratum to a depth of 60 inches is mottled loam. It is brown in the upper part and light olive brown in the lower part. In places the subsoil does not have an accumulation of lime within a depth of 16 inches.

Included with this soil in mapping are small areas of the saline Hamerly soils and the Parnell and Tonka soils. Also included are some poorly drained soils that are in depressions and have an accumulation of lime within 16 inches of the surface. These included soils make up about 10 percent of the unit. The saline Hamerly soils occur as areas intermingled with areas of this Hamerly soil. The very poorly drained Parnell soils are in deep depressions. The poorly drained Tonka soils are in depressions.

Permeability is moderately slow in the Hamerly soil, and runoff is slow. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; stripcropping; providing annual buffer strips, such as strips of flax; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture. Maintaining an adequate cover of the important or suitable plants helps to control erosion.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The limitations of moderately slow permeability and seasonal high water table in septic tank absorption

fields can be overcome by using a mound system.

The land capability classification is IIe. The productivity index for spring wheat is 79. The range site is Limy Subirrigated.

90—Hamerly-Tonka complex, 0 to 3 percent slopes. These deep soils are on till plains. The somewhat poorly drained, level and nearly level Hamerly soil is on flats. The poorly drained, level Tonka soil is in shallow depressions. It is subject to ponding. Individual areas range from 4 acres to more than 80 acres in size. They are 50 to 60 percent Hamerly soil and 30 to 45 percent Tonka soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Hamerly soil has a very dark gray loam surface layer about 6 inches thick. The subsoil is mottled, limy loam about 26 inches thick. It is light brownish gray in the upper part and brown in the lower part. The substratum to a depth of about 60 inches is mottled loam. It is brown in the upper part and light olive brown in the lower part. In some areas the subsoil does not have an accumulation of lime within a depth of 16 inches. .

Typically, the Tonka soil has a black silt loam surface layer about 7 inches thick. The subsurface layer is very dark gray and dark gray, mottled silt loam about 5 inches thick. The subsoil is about 29 inches thick. It is very dark gray, mottled silty clay loam in the upper part, very dark gray silty clay loam in the next part, and olive gray, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the subsurface layer does not occur. In some areas the subsoil has an accumulation of lime within a depth of 16 inches.

Included with these soils in mapping are small areas of the Parnell and Svea soils. These included soils make up about 10 percent of the unit. The very poorly drained Parnell soils are in deep depressions. The moderately well drained Svea soils are on slight rises.

Permeability is moderately slow in the Hamerly soil and slow in the Tonka soil. Runoff is slow on the Hamerly soil and ponded on the Tonka soil. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 2 to 4 feet in the Hamerly soil and 0.5 foot above to 1.0 foot below the surface in the Tonka soil. Tilth is good in both soils.

Most areas are used for cultivated crops, but some are used for hay, range, or wetland wildlife habitat. The Hamerly soil is suited and, if drained, the Tonka soil is also suited to small grain, flax, and sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas of the Tonka soil are drained. In undrained areas of the Tonka soil, tillage, seeding, or harvesting is sometimes delayed or prevented by ponded surface water. Crops are harvested in only 5 to 7 years out of 10. The hazard of water erosion is slight on both soils. The hazard of soil blowing on the Hamerly soil is moderate, and that on the Tonka soil is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; stripcropping; providing annual buffer strips, such as strips of flax; and providing field windbreaks help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. The Tonka soil and the ponded water provide habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

In areas where these soils are used as range, the important forage plants are little bluestem, big bluestem, slim sedge, wooly sedge, and prairie cordgrass. Tall wheatgrass, smooth bromegrass, reed canarygrass, switchgrass, and alfalfa are suitable hay and pasture plants. Compaction, trampling, and root shearing on the Tonka soil are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet. Soil blowing on the Hamerly soil is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable forage plants helps to control soil blowing.

The Hamerly soil and the Tonka soil, if drained, are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas of the Tonka soil generally are unsuited. Wetness of the Tonka soil is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on the Tonka soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

The Hamerly soil is suited to buildings, but it is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling.

Providing drainage also helps to prevent seepage into basements. The moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The Tonka soil generally is unsuited to buildings and septic tank absorption fields because of the ponding, the seasonal high water table, and the slow permeability. Better sites generally are nearby.

The land capability classification of the Hamerly soil is IIe, and that of the Tonka soil is IIw. The productivity index of the unit for spring wheat ranges from 68 to 85, depending on the degree of drainage of the Tonka soil. The range site of the Hamerly soil is Limy Subirrigated, and that of the Tonka soil is Wet Meadow.

91—Hecla loamy fine sand, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on delta plains. Individual areas range from 10 acres to more than 1,500 acres in size.

Typically, the surface soil is about 15 inches thick. It is very dark gray. It is loamy fine sand in the upper part and fine sand in the lower part. The next layer is very dark grayish brown fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and light olive brown in the lower part. In some places the substratum is not mottled. In other places it is loam or silt loam below a depth of 40 inches. In some areas the surface soil is fine sandy loam.

Included with this soil in mapping are small areas of the Aylmer and Ulen soils and a noncalcareous, somewhat poorly drained soil in swales. These included soils make up about 10 percent of the unit. The Aylmer soils have a surface soil that is thinner than that of the Hecla soil. Also, they contain less organic matter. The Aylmer soils occur as areas intermingled with areas of the Hecla soil. The somewhat poorly drained Ulen soils are in swales.

Permeability is rapid in the Hecla soil, and runoff is slow. Available water capacity is low. The organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops, pasture, or hay. Some are used as range. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity is low. Also, fallowing increases the susceptibility of the soil to blowing.

In areas where this soil is used as range, the important forage plants are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the trees and shrubs. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to building sites but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 49. The range site is Sands.

104—Colvin silt loam, channeled. This deep, level, poorly drained, highly calcareous soil is on flats on bottom land. It is subject to frequent flooding and is dissected by drainage channels that generally are too wet or too deep to cross with machinery. Individual areas range from about 10 to more than 100 acres in size.

Typically, the surface soil is black silt loam about 10 inches thick. The subsoil is silt loam about 28 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled silt loam. In some places a layer of lime accumulation is below a depth of 16 inches. In other places the surface soil and subsoil have an accumulation of salts. In some areas the substratum is coarse sand.

Included with this soil in mapping are small areas of the very poorly drained Colvin soils and small areas of water in depressions and channels. These soils and water make up about 5 percent of the unit.

Permeability is moderately slow in the Colvin soil, and runoff is very slow. Available water capacity and the organic matter content are high. A seasonal high water table is within a depth of 1 foot.

Most areas are used as range, pasture, or hay. Because of wetness, flooding, and the meandering channels, this soil generally is unsuited to cultivated crops and to trees and shrubs.

In areas where this soil is used as range, the important forage plants are slim sedge and prairie cordgrass. Creeping foxtail, big bluestem, and alfalfa are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet. Soil blowing is a problem, especially if the range is overgrazed. Maintaining an adequate cover of the important or suitable range plants helps to control soil blowing.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding, the seasonal high water table, and the moderately slow permeability. Better sites generally are nearby.

The land capability classification is VIw. The productivity index for spring wheat is 0. The range site is Wet Meadow.

105—Letcher fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained, alkali soil is on flats and in swales on outwash plains. Individual areas range from 5 acres to more than 50 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 4 inches thick. The subsoil is very dark grayish brown, dense fine sandy loam about 13 inches thick. The next layer is very dark brown fine sandy loam about 8 inches thick. Below this is light olive brown loam about 11 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled fine sandy loam. In places the subsoil is friable and nonalkali.

Included with this soil in mapping are small areas of the Maddock soils. Also included are small areas of somewhat poorly drained, alkali soils. These included soils make up about 5 percent of the unit. The Maddock soils do not have an alkali subsoil. They are on the knolls and ridges. The somewhat poorly drained, alkali soils occur as areas intermingled with areas of the Letcher soil.

Permeability is slow in the upper part of the Letcher soil and moderately rapid in the lower part. Runoff is slow. Available water capacity and the organic matter content are moderate. A seasonal high water table is at a depth of 3.5 to 6.0 feet. Tilth is poor. The root zone is shallow because of the dense, alkali subsoil.

Most areas are used for cultivated crops. Because of the dense, alkali subsoil, this soil is very poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of moisture available early in the growing season. The main concerns in managing cultivated areas are controlling soil blowing and improving root penetration in the dense, alkali subsoil. Crops growing on this soil characteristically are stunted because of moisture stress. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing alfalfa and managing crop residue help to increase the rate of water infiltration, improve tilth, and improve penetration of roots in the dense, alkali subsoil. Little benefit is derived from fallowing because the available water capacity is moderate. Also, fallowing increases the susceptibility of the soil to blowing.

In areas where this soil is used as range, the important forage plants are western wheatgrass and blue grama. Intermediate wheatgrass, pubescent wheatgrass, green needlegrass, and alfalfa are suitable

hay and pasture plants. The dense subsoil, which restricts root penetration, and the salts, which limit the water available to plants, are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings and septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by using a mound system.

The land capability classification is IVs. The productivity index for spring wheat is 25. The range site is Sandy Claypan.

106—Swenoda-Larson fine sandy loams, 0 to 3 percent slopes. These deep, level and nearly level, moderately well drained soils are on windblown till plains. The Swenoda soil is on flats. The alkali Larson soil is in swales. Individual areas range from 5 acres to more than 200 acres in size. They are 50 to 60 percent Swenoda soil and 40 to 45 percent Larson soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Swenoda soil has a black fine sandy loam surface soil about 14 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The next layer is grayish brown, mottled silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum is loamy fine sand. In other places the surface soil and subsoil are loam or loamy fine sand.

Typically, the Larson soil has a black fine sandy loam surface soil about 12 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 2 inches thick. The subsoil is about 22 inches thick. It is dense, dark brown clay loam in the upper part and yellowish brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In places, the subsoil is only slightly dense and the surface soil is loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Wyndmere soils in depressions. These included soils make up about 5 percent of the unit.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. It is slow in the Larson soil. Runoff is slow on both soils. Available water capacity is high in the Swenoda soil and moderate in the Larson soil. The organic matter content is high in both soils. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil and at a depth of 3 to 6 feet in the Larson soil. Tilth is good in the Swenoda soil and poor in the Larson soil. The root zone is shallow in the Larson soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are controlling soil blowing and improving root penetration in the dense, alkali subsoil of the Larson soil. Crops growing on the Larson soil characteristically are stunted because of moisture stress. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue help to increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Larson soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, prairie sandreed, and blue grama. Pubescent wheatgrass and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. The dense subsoil, which restricts root penetration, and the salts, which reduce the amount of water available to plants, are also problems in the Larson soil. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Swenoda soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and

environmental plantings. It has no critical limitations. The Larson soil is suited to only a few of the drought- and salt-tolerant, climatically adapted species. Individual trees and shrubs growing on these soils vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the trees and shrubs. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

The Swenoda soil is suited to buildings, but the Larson soil is poorly suited. Both soils are poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The slow and moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification of the Swenoda soil is IIIe, and that of the Larson soil is IVs. The productivity index of the unit for spring wheat is 57. The range site of the Swenoda soil is Sandy, and that of the Larson soil is Claypan.

106B—Swenoda-Larson fine sandy loams, 3 to 6 percent slopes. These deep, undulating, moderately well drained soils are on windblown till plains. The Swenoda soil is on rises. The alkali Larson soil is in swales. Individual areas range from 10 acres to more than 250 acres in size. They are 45 to 55 percent Swenoda soil and 40 to 45 percent Larson soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Swenoda soil has a black fine sandy loam surface soil about 14 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The next layer is grayish brown, mottled silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the substratum is loamy fine sand. In other places the surface soil and subsoil are loam or loamy fine sand.

Typically, the Larson soil has a black fine sandy loam surface soil about 12 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 2 inches thick. The subsoil is about 22 inches thick. It is dense, dark brown clay loam in the upper part and yellowish brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is olive brown, mottled loam. In some places, the subsoil is only slightly dense and the surface soil is loam. In other places the subsoil and substratum are fine sandy loam.

Included with these soils in mapping are small areas of the Buse, Stirum, and Towner soils. These included soils make up about 5 percent of the unit. The Buse soils have a loam surface layer and subsoil. They are on knolls. The Towner soils have a loamy fine sand surface soil and subsoil. They occur as areas intermingled with areas of the Swenoda soil. The Stirum soils are poorly drained and are in depressions.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. It is slow in the Larson soil. Runoff is slow on both soils. Available water capacity is high in the Swenoda soil and moderate in the Larson soil. The organic matter content is high in both soils. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil and at 3 to 6 feet in the Larson soil. Tilth is good in the Swenoda soil and fair in the Larson soil. The root zone is shallow in the Larson soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are controlling erosion and improving root penetration in the dense, alkali subsoil of the Larson soil. Crops growing in the Larson soil characteristically are stunted because of moisture stress. The hazard of soil blowing is severe, and that of water erosion is moderate. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing and water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Larson soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, prairie sandreed, and blue grama. Pubescent wheatgrass and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if

the range is overgrazed. The dense subsoil, which restricts root penetration, and the salts, which reduce the amount of water available to plants, are also problems in the Larson soil. Vegetation is difficult to reestablish in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding.

The Swenoda soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. The Larson soil is suited to only a few of the drought- and salt-tolerant, climatically adapted species. Individual trees and shrubs vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

The Swenoda soil is suited to buildings, but the Larson soil is poorly suited. Both soils are poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The slow and moderately slow permeability and the seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification of the Swenoda soil is IIIe, and that of the Larson soil is IVs. The productivity index of the unit for spring wheat is 49. The range site of the Swenoda soil is Sandy, and that of the Larson soil is Claypan.

107B—Lohnes-Claire coarse sands, 0 to 6 percent slopes. These deep, level to undulating soils are on outwash plains and delta plains. The well drained Lohnes soil is on flats. The excessively drained Claire soil is on rises. Individual areas range from 10 acres to more than 2,000 acres in size. They are 60 to 85 percent Lohnes soil and 10 to 35 percent Claire soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Lohnes soil has a black coarse sand surface soil about 11 inches thick. The subsoil is coarse sand about 17 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and dark yellowish brown in the lower part. In some places the substratum is mottled at a depth of 18 to 30 inches. In other places, the surface soil is loamy fine sand and the substratum fine sand.

Typically, the Claire soil has a very dark gray coarse sand surface layer about 9 inches thick. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and brown in the lower part.

Included with these soils in mapping are small areas of the somewhat poorly drained Karlsruhe soils on flats. These included soils make up about 5 percent of the unit.

Permeability is rapid in the Lohnes and Claire soils, and runoff is very slow. Available water capacity is low in both soils. The organic matter content is moderately low. Tilth is poor in both soils.

Most areas are used for hay, range, or pasture, but some are used for cultivated crops. Because of droughtiness and a severe hazard of soil blowing, these soils generally are unsuited to cultivated crops. The important range forage plants are prairie sandreed and needleandthread. Intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

The Lohnes soil is suited to only a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Claire soil generally is unsuited to trees and shrubs. The Lohnes soil is droughty and moisture stress commonly affects the trees and shrubs. Supplemental watering helps to ensure the survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is very low. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are well suited to buildings but are poorly suited to septic tank absorption fields. Because of the rapid permeability, they readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of both soils is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Lohnes soil is Sands, and that of the Claire soil is Thin Sands.

108—Falsen-Karlsruhe complex, 0 to 3 percent slopes. These deep, level and nearly level soils are on outwash plains and delta plains. The moderately well drained Falsen soil is on rises. The somewhat poorly drained Karlsruhe soil is in swales. Individual areas range from 10 acres to more than 500 acres in size. They are 65 to 75 percent Falsen soil and 25 to 35 percent Karlsruhe soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Falsen soil has a black coarse sand surface soil about 12 inches thick. The subsoil is very dark grayish brown coarse sand about 13 inches thick. The next layer is very dark grayish brown, mottled coarse sand about 11 inches thick. The substratum to a depth of about 60 inches is mottled coarse sand. It is grayish brown in the upper part and light olive brown in the lower part.

Typically, the Karlsruhe soil has a sandy loam surface soil about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark gray loamy coarse sand about 4 inches thick. The subsoil is very dark grayish brown, mottled, limy coarse sand about 5 inches thick. The next layer is dark brown, mottled coarse sand about 10 inches thick. The substratum to a depth of about 60 inches is mottled coarse sand. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. In some places the subsoil does not have an accumulation of lime within a depth of 16 inches.

Included with these soils in mapping are small areas of the Claire and Verendrye soils. These included soils make up about 5 percent of the unit. The excessively drained Claire soils are on knolls. The poorly drained Verendrye soils are in shallow depressions.

Permeability is rapid in the Falsen and Karlsruhe soils. Runoff is very slow on the Falsen soil and slow on the Karlsruhe soil. Available water capacity is low in both soils. The organic matter content is moderate in both soils. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Falsen soil and at 2.5 to 5.0 feet in the Karlsruhe soil. Tilth is fair in both soils.

Most areas are used for hay, range, or pasture, but some are used for cultivated crops. Because of droughtiness, these soils are, at best, poorly suited to small grain, flax, and sunflowers. They are best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. Wetness in the Karlsruhe soil delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity is very low. Also, fallowing increases the susceptibility of the soil to blowing.

In areas where these soils are used as range, the important forage plants are little bluestem, big bluestem, prairie sandreed, and needleandthread. Tall wheatgrass, big bluestem, little bluestem, green needlegrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to

prevent seepage into basements. Because of the rapid permeability, these soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the Falsen soil is VIe, and that of the Karlsruhe soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Falsen soil is Sands, and that of the Karlsruhe soil is Limy Subirrigated.

109D—Lohnes and Maddock soils, 6 to 15 percent slopes. These deep, gently rolling and rolling, well drained soils are on ridges and side slopes on dissected delta plains and outwash plains. Individual areas range from 10 acres to more than 100 acres in size. They can consist entirely of Lohnes soil, entirely of Maddock soil, or of any combination of both soils.

Typically, the Lohnes soil has a black coarse sand surface soil about 11 inches thick. The subsoil is coarse sand about 17 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The substratum to a depth of about 60 inches is coarse sand. It is dark brown in the upper part and dark yellowish brown in the lower part. In places the surface layer and subsoil are sandy loam.

Typically, the Maddock soil has a loamy fine sand surface soil about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loamy fine sand. In places the substratum is mottled at a depth of 20 to 40 inches.

Included with these soils in mapping are small areas of the Claire, Serden, and Towner soils. These included soils make up about 15 percent of the unit. The excessively drained Claire and Serden soils are on knolls and ridges. The Towner soils are silt loam in the lower part of the subsoil and the substratum. They are on flats and in swales.

Permeability is rapid in the Lohnes and Maddock soils. Runoff is very slow on the Lohnes soil and slow on the Maddock soil. Available water capacity is low in both soils. The organic matter content is moderately low.

Most areas are used for hay, range, or pasture. Because of droughtiness, slope, and the severe hazard of soil blowing, these soils generally are unsuited to cultivated crops. The important range forage plants are prairie sandreed and needleandthread. Intermediate wheatgrass, pubescent wheatgrass, prairie sandreed, and sweetclover are suitable hay and pasture plants. Soil blowing is a hazard, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

These soils are suited to only a few of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soils are droughty, and moisture stress commonly affects the trees and shrubs. Supplemental watering helps to ensure the survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is very low. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. The slope is a limitation affecting both uses, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. Because of the rapid permeability, these soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is VIe. The productivity index of the unit for spring wheat is 0. The range site for both soils is Sands.

110—Ludden clay, ponded. This deep, level, very poorly drained soil is in depressions and oxbows on bottom land. It is subject to frequent flooding and to ponding. Individual areas range from 15 acres to more than 3,000 acres in size.

Typically, a cover of undecomposed stems and roots is at the surface. The surface layer is black clay about 5 inches thick. The subsoil is about 12 inches thick. It is mottled. It is black silty clay in the upper part and very

dark gray silty clay loam in the lower part. The next layer is black clay about 13 inches thick. Below this is very dark gray clay about 13 inches thick. The substratum to a depth of about 60 inches is dark olive gray clay. In places the soil is not ponded.

Included with this soil in mapping are small areas of water and small areas of very poorly drained organic soils. These soils and water make up about 5 percent of the unit. The organic soils occur as areas intermingled with areas of the Ludden soil.

Permeability is slow in the Ludden soil, and runoff is ponded. Available water capacity and the organic matter content are high. A seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas are used for wetland wildlife habitat. This soil is best suited to this use. Because of the ponded surface water, it generally is unsuited to cultivated crops, hay, pasture, trees, and shrubs. Locating suitable drainage outlets is difficult. As a result, few areas are drained. The soil and ponded water provide excellent habitat for wetland wildlife. The main concerns in managing wetland wildlife habitat are maintaining the natural water level and preventing siltation.

This soil generally is unsuited to buildings and septic tank absorption fields because of the ponding and the flooding. Better sites generally are nearby.

The land capability classification is VIIIw. The productivity index for spring wheat is 0. A range site is not assigned.

111—Ludden clay. This deep, level, poorly drained, slightly saline and moderately saline soil is on flats on bottom land. It is subject to occasional flooding. Individual areas range from 10 acres to more than 2,000 acres in size.

Typically, a cover of undecomposed stems and roots is at the surface. The surface layer is black clay about 5 inches thick. The subsoil is about 12 inches thick. It is mottled. It is black silty clay in the upper part and very dark gray silty clay loam in the lower part. The next layer is black clay about 13 inches thick. Below this is very dark gray clay about 13 inches thick. The substratum to a depth of about 60 inches is dark olive gray clay.

Included with this soil in mapping are small areas of the Ludden and Ryan soils. These included soils make up about 5 percent of the unit. The very poorly drained Ludden soils are ponded. They are in depressions and oxbows. The poorly drained Ryan soils have a dense, alkali subsoil. They occur as areas intermingled with areas of the Ludden soil.

Permeability is slow in the Ludden soil, and runoff is very slow. Available water capacity and the organic matter content are high. A seasonal high water table is within a depth of 2 feet. Tilth is poor.

Most areas are used for hay (fig. 7). Some are used as range or cultivated crops. If drained, this soil is suited to small grain, flax, and sunflowers. It is well suited to hay. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In some years flooding delays tillage and seeding in the spring and occasionally later in the growing season. The soil is best tilled only within a narrow range of moisture content because it is very sticky and tends to puddle when wet and is very hard and tends to become cloddy when dry. Fall tillage and the effects of freezing, thawing, wetting, and drying over winter improve tilth of the surface layer and aid seedbed preparation; however, they also increase the susceptibility of the soil to blowing. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and planting field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem and green needlegrass. Creeping foxtail, reed canarygrass, switchgrass, and alsike clover are suitable hay and pasture plants. Compaction, trampling, and root shearing are problems, especially if the range or pasture is grazed when the soil is wet. Grazing should be deferred when the soil is wet. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding and the seasonal high water table. Better sites generally are nearby.

The land capability classification is IIIs. The productivity index for spring wheat ranges from 37 to 64, depending on the degree of drainage and salinity. The range site is Overflow.

Figure 7.—An area of Ludden clay used for hay.

112B—Maddock-Hecla loamy fine sands, 1 to 6 percent slopes. These deep soils are on delta plains and outwash plains. The well drained, nearly level and undulating Maddock soil is on knolls and ridges. The moderately well drained, nearly level Hecla soil is on flats and in swales. Individual areas range from 10 acres to more than 200 acres in size. They are 60 to 75 percent Maddock soil and 20 to 35 percent Hecla soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Maddock soil has a loamy fine sand surface soil about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loamy fine sand.

Typically, the Hecla soil has a very dark gray surface soil. It is about 15 inches thick. It is loamy fine sand in the upper part and fine sand in the lower part. The next layer is very dark grayish brown fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and light olive brown in the lower part.

Included with these soils in mapping are small areas of the Serden and Ulen soils. These included soils make up about 5 percent of the unit. The Serden soils have a thin surface layer. They are on knolls and ridges. The somewhat poorly drained Ulen soils are in shallow depressions.

Permeability is rapid in the Maddock and Hecla soils,

and runoff is slow. Available water capacity is low in both soils. The organic matter content is moderately low. The Hecla soil has a seasonal high water table at a depth of 3 to 6 feet. Tilth is fair in both soils.

Most areas are used for cultivated crops, pasture or hay, but some are used as range. Because of droughtiness, these soils are poorly suited to small grain, flax, and sunflowers. They are best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of moisture available early in the growing season. The main concerns in managing cultivated areas are controlling soil blowing and overcoming droughtiness. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity is low. Also, fallowing increases the susceptibility of the soil to blowing.

In areas where these soils are used as range, the important forage plants are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, sand bluestem, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

The Maddock soil is suited to only a few and the Hecla soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Maddock soil is droughty, and moisture stress commonly affects the trees and shrubs. Supplemental watering helps to ensure the survival of seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is very low. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

The Maddock soil is well suited and the Hecla soil is suited to buildings. Both soils are poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements on the Hecla soil. Because of the rapid permeability, these soils readily absorb but do not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table in the Hecla soil. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of both soils is IVe. The productivity index of the unit for spring wheat is 41. The range site for both soils is Sands.

124—Marysland silt loam. This deep, level, poorly drained, highly calcareous soil is in depressions and channels on outwash plains. It is subject to rare flooding. Individual areas range from 5 acres to more than 30 acres in size.

Typically, a cover of undecomposed stems, leaves, and roots is at the surface. The surface layer is black silt loam about 9 inches thick. The subsoil is very dark gray silt loam about 8 inches thick. The next layer is very dark gray sandy clay loam about 18 inches thick. The substratum to a depth of about 60 inches is olive gray coarse sand. In some places the layer of lime accumulation is below a depth of 16 inches. In other places the depth to coarse sand is more than 40 inches.

Included with this soil in mapping are small areas of the Arveson, Verendrye, Wyndmere, and Wyrene soils. These included soils make up about 10 percent of the unit. The Arveson and Verendrye soils occur as areas intermingled with areas of the Marysland soil. The Arveson soils have a sand substratum. The Verendrye soils have a loamy coarse sand surface layer. The somewhat poorly drained Wyndmere and Wyrene soils are on flats.

Permeability is moderate in the upper part of the Marysland soil and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The organic matter content is high. A seasonal high water table is at 1.0 to 2.5 feet below the surface. Tilth is good. The root zone is moderately deep because of the coarse sand substratum.

Most areas are used as range, pasture, or hay. If drained, this soil is suited to small grain, flax, and

sunflowers. Locating suitable drainage outlets generally is difficult. As a result, few areas are drained. In undrained areas, wetness sometimes delays or prevents tillage, seeding, or harvesting. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and planting field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem and switchgrass. Creeping foxtail, big bluestem, and alsike clover are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

If drained, this soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Undrained areas generally are unsuited. Wetness is a critical limitation affecting survival, growth, and vigor. The grasses and weeds growing on this soil are abundant and persistent. Eliminating this ground cover before the trees and shrubs are planted and then controlling its regrowth improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table, flooding, and the poor filtering capacity. Better sites generally are nearby.

The land capability classification is IIw. The productivity index for spring wheat ranges from 39 to 60, depending on the degree of drainage. The range site is Subirrigated.

127—Pits, gravel. This unit consists of areas from which the soil material has been removed to mine the underlying sand and gravel. The mining activity has resulted in irregularly shaped pits and fill areas. Individual areas range from 3 acres to more than 40 acres in size. Most areas are barren. Included in this unit are some areas of mine spoil from which coal has been removed.

This unit generally is unsuited to cultivated crops, hay, pasture, and trees. The suitability for buildings, septic tank absorption fields, and other uses should be determined by onsite investigations.

The land capability classification is VIIIs. The productivity index for spring wheat is 0. A range site is not assigned.

136—Ryan loam. This deep, level, poorly drained, alkali soil is on flats and in swales on bottom land. It is subject to occasional flooding. Individual areas range from 5 acres to more than 1,000 acres in size.

Typically, the surface layer is black loam about 1 inch thick. The subsoil is silty clay about 34 inches thick. It is black in the upper part, very dark gray in the next part, and dark gray in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In some places the subsoil is nonalkali. In cultivated areas the surface layer is silty clay. In some areas salts are in the upper part of the subsoil.

Included with this soil in mapping are small areas of the poorly drained, nonalkali Ludden soils. These soils occur as areas intermingled with areas of the Ryan soil. The included soils make up about 5 percent of the unit.

Permeability is very slow in the Ryan soil. Runoff is very slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is within a depth of 1 foot. The root zone is very shallow because of the dense, alkali subsoil.

Most areas are used as range or hay. Because of the dense, alkali subsoil and the salts, this soil generally is unsuited to cultivated crops. In the areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and blue grama. Tall wheatgrass, western wheatgrass, and sweetclover are suitable hay and pasture plants. The dense, alkali subsoil, which restricts root penetration, and the salts, which reduce the available water capacity, are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of this soil frequently contain salty water.

The Ryan soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs growing on these soils vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival

and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding, seasonal high water table, and shrink-swell potential. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Thin Claypan.

137—Harriet silt loam. This deep, level, poorly drained, alkali, strongly saline soil is on flats and in depressions on bottom land. It is subject to occasional flooding. Individual areas range from 10 acres to more than 1,000 acres in size.

Typically, the surface layer is black silt loam about 1 inch thick. The subsoil is about 22 inches thick. It is black, dense silty clay in the upper part and very dark gray clay loam in the lower part. The next layer is dark grayish brown, mottled clay loam about 12 inches thick. Below this is grayish brown, mottled fine sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled loamy fine sand. In places the substratum is light olive brown.

Included with this soil in mapping are small areas of somewhat poorly drained soils that occur as areas intermingled with areas of the Harriet soil. These included soils make up about 5 percent of the unit.

Permeability is very slow in the Harriet soil. Runoff is very slow. Available water capacity and the organic matter content are moderate. The salts in the soil reduce the amount of water available to plants. A seasonal high water table is within a depth of 1 foot. The root zone is very shallow because of the dense, alkali subsoil.

Most areas are used as range or hay. Because of the dense, alkali subsoil and the salts, this soil generally is unsuited to cultivated crops and to trees and shrubs. In areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Tall wheatgrass, beardless wildrye, western wheatgrass, and sweetclover are suitable hay and pasture plants. The dense, alkali subsoil, which restricts root penetration, and the salts, which reduce the available water capacity, are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants helps to prevent denuding. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding, seasonal high water table, and very slow permeability. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Saline Lowland.

139F—Serden sand, 3 to 50 percent slopes. This deep, undulating to very steep, excessively drained soil is on hummocks and dunes on windblown delta plains. Individual areas range from 10 acres to more than 800 acres in size.

Typically, the surface layer is very dark gray sand about 2 inches thick. The substratum to a depth of about 60 inches is sand. It is dark grayish brown in the upper part and brown in the lower part.

Included with this soil in mapping are small areas of the Aylmer, Fossum, and Maddock soils and small areas of blown-out land. These included soils make up about 5 percent of the unit. The Aylmer soils are mottled in the lower part of the substratum. They are in swales. The poorly drained Fossum soils are in depressions. The well drained Maddock soils occur as areas intermingled with areas of the Serden soil.

Permeability is rapid in the Serden soil, and runoff is very slow. Available water capacity and the organic matter content are low.

Most areas are used as range (fig. 8). Because of droughtiness, the slope, and the severe hazard of soil blowing, these soils generally are unsuited to cultivated crops, pasture, hay, and trees and shrubs. In areas where this soil is used as range, the important forage plants are prairie sandreed, sand bluestem, and needleandthread. Soil blowing is a hazard, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important plants helps to control soil blowing and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is poorly suited to buildings and septic tank absorption fields. The slope is a limitation for both uses, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

Figure 8.—An area of Serden sand, 3 to 50 percent slopes, used as range. This soil is damaged easily by soil blowing.

The land capability classification is VIIe. The productivity index for spring wheat is 0. The range site is Thin Sands.

145B—Sioux gravelly sandy loam, 1 to 6 percent slopes. This deep, nearly level and undulating, excessively drained soil is on flats and rises on outwash plains and terraces. Individual areas range from 5 acres to more than 100 acres in size.

Typically, the surface layer is very dark gray gravelly sandy loam about 5 inches thick. The next layer is very dark grayish brown gravelly loamy sand about 2 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand. In some places the surface layer is gray and only 2 to 5 inches thick. In other places it is gravelly loamy sand.

Included with this soil in mapping are small areas of Arvilla soils and somewhat excessively drained soils that have a loam surface layer and subsoil. These included soils make up about 20 percent of the unit. They have sand and gravel within a depth of 14 to 20 inches. The two soils occur as areas intermingled with areas of the Sioux soil.

Permeability is very rapid in the Sioux soil, and runoff is slow. Available water capacity is low. The organic matter content is moderately low. The root zone is very shallow because of the very gravelly coarse sand substratum.

Most areas are used as range or pasture. Because of droughtiness, this soil generally is unsuited to cultivated

crops and to trees and shrubs. In areas where this soil is used as range, the important forage plants are needleandthread and blue grama. Crested wheatgrass, green needlegrass, slender wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is well suited to buildings but is poorly suited to septic tank absorption fields. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

145E—Sioux gravelly sandy loam, 6 to 25 percent slopes. This deep, gently rolling to hilly, excessively drained soil is on knolls and ridges on outwash plains. Individual areas range from 3 acres to more than 400 acres in size.

Typically, the surface layer is very dark gray gravelly sandy loam about 5 inches thick. The next layer is very dark grayish brown gravelly loamy sand about 2 inches thick. The substratum to a depth of about 60 inches is dark grayish brown very gravelly coarse sand. In some places the surface layer is gray and only 2 to 5 inches thick. In other places it is gravelly loamy sand.

Included with this soil in mapping are small areas of Arvilla soils and some excessively drained soils that have a loam surface layer and subsoil. These included soils make up about 5 percent of the unit. They have sand and gravel within a depth of 14 to 20 inches. The two soils occur as areas intermingled with areas of the Sioux soil.

Permeability is very rapid in the Sioux soil, and runoff is slow. Available water capacity is low. The organic matter content is moderately low. The root zone is very shallow because of the very gravelly coarse sand substratum.

Most areas are used as range or pasture. Because of droughtiness and the severe hazard of soil blowing, this soil generally is unsuited to cultivated crops and to trees and shrubs. In areas where this soil is used as range, the important forage plants are needleandthread and western wheatgrass. Intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and droughtiness are problems, especially if the range or pasture is overgrazed. Reestablishing vegetation is difficult in denuded areas. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil, control soil blowing, and prevent denuding. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. Slope is a limitation for both uses, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. Because of the very rapid permeability, it readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Very Shallow.

151—Stirum fine sandy loam. This deep, level, poorly drained, alkali soil is in shallow depressions on delta plains and outwash plains. Individual areas range from 3 acres to more than 15 acres in size.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsoil is about 33 inches thick. It is dense and alkali. It is very dark gray fine sandy loam in the upper part, gray and light gray fine sandy loam in the next part, and light olive brown, mottled, stratified fine sandy loam and very fine sandy loam in the lower part. The next layer is light olive brown, mottled loamy fine sand about 8 inches thick. The substratum to a depth of about 60 inches is olive brown fine sandy loam.

Included with this soil in mapping are small areas of the Arveson and Letcher soils and the saline Wyndmere soils. These included soils make up about 15 percent of the unit. The Arveson soils and the saline Wyndmere soils do not have a dense, alkali subsoil. The Arveson soils occur as areas intermingled with areas of the

Stirum soil. The Wyndmere soils are on flats. The moderately well drained Letcher soils are on rises.

Permeability is moderately slow in the upper part of the Stirum soil and moderately rapid in the lower part. Runoff is very slow. Available water capacity is moderate. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is 1 foot to 3 feet below the surface. The root zone is very shallow because of the dense, alkali subsoil.

Most areas are used as range or hay. Because of the dense, alkali subsoil, this soil generally is unsuited to cultivated crops. In areas where this soil is used as range, the important forage plants are switchgrass, big bluestem, and porcupinegrass. Tall wheatgrass, western wheatgrass, alkali sacaton, and sweetclover are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

The Stirum soil is suited to only a few of the drought- and salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs growing on this soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the trees and shrubs.

This soil generally is unsuited to buildings and septic tank absorption fields because of the seasonal high water table. Better sites generally are nearby.

The land capability classification is VIs. The productivity index for spring wheat is 0. The range site is Subirrigated.

157—Swenoda fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on windblown till plains and lacustrine plains. Individual areas range from 5 acres to more than 300 acres in size.

Typically, the surface soil is black fine sandy loam about 14 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The next layer is grayish brown, mottled silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled silty clay loam. In some places the substratum is fine sandy loam between depths of 40 and 60 inches. In other places the subsoil is loamy fine sand.

Included with this soil in mapping are small areas of the Towner and Wyndmere soils. These included soils make up about 15 percent of the unit. The Towner soils have a loamy fine sandy surface soil. They occur as areas intermingled with areas of the Swenoda soil. The somewhat poorly drained Wyndmere soils are in swales.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. Runoff is slow. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 2.5 to 4.0 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. It is best suited to rye and winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil bowing is severe, and that of water erosion is slight. The soil is slightly droughty. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where this soil is used as range, the important forage plants are needleandthread and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, switchgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The shrink-swell potential

is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements. The moderately slow permeability and seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system.

The land capability classification is IIIe. The productivity index for spring wheat is 77. The range site is Sandy.

158B—Swenoda-Barnes complex, 0 to 6 percent slopes. These deep, level to undulating soils are on windblown till plains. The moderately well drained Swenoda soil is on flats and in swales. The well drained Barnes soil is on flats and rises. Individual areas range from 20 acres to more than 600 acres in size. They are 45 to 60 percent Swenoda soil and 30 to 45 percent Barnes soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Swenoda soil has a black fine sandy loam surface soil about 14 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. The next layer is grayish brown, mottled clay loam about 10 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the substratum is fine sandy loam between depths of 40 and 60 inches.

Typically, the Barnes soil has a black loam surface layer about 7 inches thick. The subsoil is loam about 28 inches thick. It is very dark brown in the upper part, dark brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil and substratum are calcareous throughout.

Included with these soils in mapping are small areas of the Larson, Maddock, and Towner soils. These included soils make up about 10 percent of the unit. The Larson and Towner soils occur as areas intermingled with areas of the Swenoda soil. The Larson soils have a dense, alkali subsoil. The Towner soils have a loamy fine sand surface layer and subsoil. The Maddock soils are loamy fine sand throughout. They are on rises.

Permeability is moderately rapid in the upper part of the Swenoda soil and moderately slow in the lower part. It is moderately slow in the Barnes soil. Runoff is slow on the Swenoda soil and medium on the Barnes soil. Available water capacity and the organic matter content are high in both soils. A seasonal high water table is at a depth of 2.5 to 4.0 feet in the Swenoda soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are well suited to small grain, flax, and sunflowers; however, the Swenoda soil is slightly droughty. Both soils are best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of moisture available early in the growing season. The main concerns in managing cultivated areas are controlling soil blowing and water erosion. The hazard of soil blowing is severe on the Swenoda soil and slight on the Barnes soil. The hazard of water erosion is slight on the Swenoda soil and moderate on the Barnes soil. Using a system of conservation tillage that includes leaving crop residue on the surface; installing grassed waterways in areas where runoff concentrates; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control water erosion and soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow and thus increasing the moisture supply in the Swenoda soil.

In areas where these soils are used as range, the important forage plants are needleandthread, prairie sandreed, green needlegrass, and porcupinegrass. Pubescent wheatgrass, smooth bromegrass, switchgrass, and alfalfa are suitable hay and pasture plants. Water erosion and soil blowing are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion and soil blowing.

The Swenoda soil is suited to all and the Barnes soil to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The soils have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings. The Swenoda soil is poorly suited to septic tank absorption fields, but the Barnes soil is suited to this use. The shrink-swell potential of the Barnes soil is a limitation on building sites. Installing a surface and foundation drainage

system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements on the Swenoda soil. The moderately slow permeability in the Barnes soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and the seasonal high water table in the Swenoda soil are limitations, but they can be overcome by using a mound system.

The land capability classification of the Swenoda soil is IIIe, and that of the Barnes soil is IIe. The productivity index of the unit for spring wheat is 70. The range site of the Swenoda soil is Sandy, and that of the Barnes soil is Silty.

163B—Towner loamy fine sand, 0 to 6 percent slopes. This deep, level to undulating, moderately well drained soil is on flats and rises on windblown till plains and lacustrine plains. Individual areas range from 10 acres to more than 1,000 acres in size.

Typically, the surface soil is loamy fine sand about 19 inches thick. It is very dark gray in the upper part and very dark brown in the lower part. The subsoil is dark brown. It is about 16 inches thick. It is fine sand in the upper part and loam in the lower part. The next layer is brown loam about 10 inches thick. The substratum to a depth of about 60 inches is dark brown, mottled clay loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the substratum is loamy fine sand or sand between depths of 40 and 60 inches. In some areas the surface layer is very dark brown.

Included with this soil in mapping are small areas of the Buse, Larson, Swenoda, and Ulen soils. These included soils make up about 10 percent of the unit. The Buse soils have a loam surface layer and subsoil. They are on knobs and ridges. The Larson and Swenoda soils occur as areas intermingled with areas of the Towner soil. The Larson soils have a dense, alkali subsoil. The Swenoda soils have a fine sandy loam surface soil and subsoil. The somewhat poorly drained Ulen soils are in swales.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. Runoff is slow. Available water capacity is moderate. The organic matter content is moderately low. A seasonal high water table is at a depth of 3 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops or hay. Some areas are used for pasture or range. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity is moderate. Also, fallowing increases the susceptibility of the soil to blowing.

In areas where this soil is used as range, the important forage plants are needleandthread, porcupinegrass, and prairie sandreed. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants at a height that traps snow helps to store water in the soil and control soil blowing. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

This soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It is somewhat droughty, however, and the trees and shrubs growing on it commonly are affected by moisture stress, particularly during the establishment period. Supplemental watering helps to ensure the survival of the seedlings. Little benefit is derived from fallowing the season prior to planting because the available water capacity is moderate. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage

also helps to prevent seepage into basements. The moderately slow permeability and seasonal high water table are limitations in septic tank absorption fields, but they can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 50. The range site is Sands.

164C—Towner-Buse-Maddock complex, 3 to 9 percent slopes. These deep soils are on windblown till plains. The moderately well drained, undulating Towner soil is on side slopes and in swales. The well drained, undulating and gently rolling Buse soil is on shoulder slopes and knolls. The well drained, undulating Maddock soil is on side slopes. Individual areas range from 5 acres to more than 150 acres in size. They are 35 to 45 percent Towner soil, 25 to 40 percent Buse soil, and 10 to 25 percent Maddock soil. The three soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Towner soil has a loamy fine sand surface soil about 19 inches thick. It is very dark gray in the upper part and very dark brown in the lower part. The subsoil is about 16 inches thick. It is dark brown. It is fine sand in the upper part and loam in the lower part. The next layer is brown loam about 10 inches thick. The substratum to a depth of about 60 inches is dark brown, mottled clay loam. In some places the dark color of the surface soil extends to a depth of only 8 to 16 inches. In other places the surface soil is very dark brown.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the surface layer is only 2 to 6 inches thick. In other places the dark color of the surface layer extends to a depth of 8 to 16 inches. In some areas the surface layer is very dark brown.

Typically, the surface soil of the Maddock soil is loamy fine sand about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loamy fine sand. In some places the dark color of the surface soil extends to a depth of only 2 to 5 inches. In other places the substratum is mottled at a depth of 20 to 40 inches.

Included with these soils in mapping are small areas of the Egeland, Larson, and Swenoda soils. These included soils make up about 10 percent of the unit. The Egeland soils are fine sandy loam throughout. They occur as areas intermingled with areas of the Maddock soil. The Larson soils have a dense, alkali subsoil. They are on flats. The Swenoda soils have a fine sandy loam surface soil. They occur as areas intermingled with areas of the Towner soil.

Permeability is rapid in the upper part of the Towner soil and moderately slow in the lower part. It is moderately slow in the Buse soil and rapid in the Maddock soil. Runoff is slow on the Towner and Maddock soils and medium on the Buse soil. Available water capacity is moderate in the Towner soil, high in the Buse soil, and low in the Maddock soil. The organic matter content is moderately low in the Towner and Maddock soils and moderate in the Buse soil. A seasonal high water table is at a depth of 3 to 6 feet in the Towner soil. Tilth is fair in the Towner and Maddock soils and good in the Buse soil.

Most areas are used for cultivated crops or hay, but some are used for pasture or range. Because the Towner and Maddock soils are droughty, they are very poorly suited to small grain, flax, and sunflowers. These soils are best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are controlling soil blowing and water erosion and overcoming droughtiness. The hazard of soil blowing is severe on the Towner and Maddock soils and moderate on the Buse soil. The hazard of water erosion is slight on the Towner and Maddock soils and moderate on the Buse soil. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control water erosion and soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow. Little benefit is derived from fallowing because the available water capacity in the Maddock and Towner soils is low and moderate. Also, fallowing increases the susceptibility of the soils to blowing.

In areas where these soils are used as range, the important forage plants are prairie sandreed, needleandthread, and porcupinegrass. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the

important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Towner and Maddock soils are suited to many and the Buse soil to only the most drought-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Optimum growth, survival, and vigor are unlikely on the Buse soil. The Towner and Maddock soils are somewhat droughty and moisture stress commonly affects the trees and shrubs, particularly during the establishment period. Supplemental watering during this period helps to ensure the survival of the seedlings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. The moderately slow permeability of the Buse soil is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field. The moderately slow permeability and seasonal high water table in the Towner soil are limitations in septic tank absorption fields, but they can be overcome by using a mound system. Because of its rapid permeability, the Maddock soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution.

The shrink-swell potential of the Buse and Towner soils is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. Providing drainage also helps to prevent seepage into basements in the Towner soil. In the Maddock and Towner soils, the sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of the three soils is IVe. The productivity index of the unit for spring wheat is 37. The range site of the Maddock and Towner soils is Sands, and that of the Buse soil is Thin Upland.

165E—Dickey-Buse-Maddock complex, 9 to 25 percent slopes. These deep, rolling and hilly, well drained soils are on windblown moraines. The Dickey and Maddock soils are on side slopes. The Buse soil is on shoulder slopes and knolls. Individual areas range from 10 acres to more than 300 acres in size. They are 35 to 45 percent Dickey soil, 30 to 40 percent Buse soil, and 15 to 30 percent Maddock soil. The three soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Dickey soil has a black loamy fine sand surface layer about 5 inches thick. The subsoil is about 42 inches thick. In sequence downward, it is very dark gray loamy fine sand, dark brown loamy fine sand, light olive brown loam, and olive brown loam. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil and substratum are loamy fine sand to a depth of 40 inches or more. In some areas the surface layer is very dark brown.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is brown loam about 9 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown loam. In some places the surface layer is only 2 to 6 inches thick. In other places the dark color of the surface layer extends to a depth of 8 to 16 inches. In some areas the surface layer is very dark brown.

Typically, the surface soil of the Maddock soil is loamy fine sand about 10 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark grayish brown loamy fine sand about 5 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loamy fine sand. In some places the dark color of the surface soil extends to a depth of only 2 to 5 inches. In other places the subsoil and substratum are loamy coarse sand. In some areas the surface soil is very dark brown.

Included with these soils in mapping are small areas of the Sioux and Swenoda soils. These included soils make up about 5 percent of the unit. The Sioux soils have a gravelly substratum. They are on ridges. The Swenoda soils are fine sandy loam in the surface soil and upper part of the subsoil. They are on flats.

Permeability is rapid in the upper part of the Dickey soil and moderately slow in the lower part. It is moderately slow in the Buse soil and rapid in the Maddock soil. Runoff is slow on the Dickey and Maddock soils and rapid on the Buse soil. Available water capacity is moderate in the Dickey soil, high in the Buse soil, and low in the Maddock soil. The organic matter content is moderately low in the Dickey and Maddock soils and moderate in the Buse soil.

Most areas are used as range. Because of the slope and the severe hazard of water erosion, these soils

generally are unsuited to cultivated crops. In areas where these soils are used as range, the important forage plants are prairie sandreed, needleandthread, little bluestem, and porcupinegrass. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion and soil blowing and prevent denuding. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to the trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted if special treatment, such as hand or scalp planting, is applied.

These soils are suited to buildings but are poorly suited to septic tank absorption fields because of the slope. The shrink-swell potential of the Buse and Dickey soils is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The slope is a limitation for building sites, but it can be overcome by designing the buildings so that they conform to the natural slope of the land. The sides of shallow excavations, such as those of basements, in the Dickey and Maddock soils tend to cave in unless they are shored.

The slope is a limitation for septic tank absorption fields, but it can be overcome by designing the field to conform to the natural slope of the land. The moderately slow permeability of the Dickey and Buse soils is a limitation, but it can be overcome by enlarging the absorption field. Because of the rapid permeability, the Maddock soil readily absorbs but does not adequately filter the effluent in absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution.

The land capability classification of the three soils is VIIe. The productivity index of the unit for spring wheat is 0. The range site of the Dickey and Maddock soils is Sands, and that of the Buse soil is Thin Upland.

172—Ulen fine sandy loam, 0 to 3 percent slopes. This deep, level and nearly level, somewhat poorly drained, highly calcareous soil is on flats on delta plains. Individual areas range from 3 acres to more than 300 acres in size.

Typically, the surface soil is about 11 inches thick. It is black fine sandy loam in the upper part and very dark grayish brown loamy fine sand in the lower part. The subsoil is loamy fine sand about 23 inches thick. It is dark grayish brown in the upper part and is brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled fine sand. In some places the layer of lime accumulation is below a depth of 16 inches. In other places the surface soil is loamy fine sand.

Included with this soil in mapping are small areas of the Arveson, Fossum, and Hecla soils. These included soils make up about 10 percent of the unit. The poorly drained Arveson and Fossum soils are in depressions. The moderately well drained Hecla soils are on rises and ridges.

Permeability is rapid in the Ulen soil, and runoff is slow. Available water capacity is low. The organic matter content is moderate. A seasonal high water table is at a depth of 2.5 to 6.0 feet. Tilth is good.

Most areas are used for cultivated crops, pasture, or hay. Some areas are used as range. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of moisture available early in the growing season. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates

of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to building sites but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 58. The range site is Limy Subirrigated.

175—Ulen-Hecla loamy fine sands, 0 to 3 percent slopes. These deep, level and nearly level soils are on windblown delta plains. The somewhat poorly drained Ulen soil is in swales. The moderately well drained Hecla soil is on flats and rises. Individual areas range from 10 acres to more than 250 acres in size. They are 55 to 70 percent Ulen soil and 25 to 40 percent Hecla soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Ulen soil has a black loamy fine sand surface soil about 11 inches thick. The subsoil is limy loamy fine sand about 23 inches thick. It is dark grayish brown in the upper part and is brown and mottled in the lower part. The substratum to a depth of about 60 inches is light olive brown, mottled fine sand. In places the surface soil is fine sandy loam. In some areas the subsoil does not have an accumulation of lime within a depth of 16 inches.

Typically, the Hecla soil has a very dark gray surface soil about 15 inches thick. It is loamy fine sand in the upper part and fine sand in the lower part. The next layer is very dark grayish brown fine sand about 15 inches thick. The substratum to a depth of about 60 inches is mottled fine sand. It is dark grayish brown in the upper part, grayish brown in the next part, and light olive brown in the lower part.

Included with these soils in mapping are small areas of the poorly drained Fossum soils in depressions. These included soils make up about 5 percent of the unit.

Permeability is rapid in the Ulen and Hecla soils, and runoff is slow. Available water capacity is low. The organic matter content is moderate in the Ulen soil and moderately low in the Hecla soil. A seasonal high water table is at a depth of 2.5 to 6.0 feet in the Ulen soil and at a depth of 3 to 6 feet in the Hecla soil. Tilth is fair in both soils.

Most areas are used for cultivated crops, pasture, or hay. Some are used as range. These soils are poorly suited to small grain, flax, and sunflowers. They are best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. Wetness delays tillage and seeding operations in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where these soils are used as range, the important forage plants are little bluestem, needleandthread, prairie sandreed, and big bluestem. Tall wheatgrass, big bluestem, pubescent wheatgrass, little bluestem, alfalfa, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing. Because of soil blowing, denuding can occur along cattle trails. It can be prevented by using a planned grazing system that controls the pattern of livestock traffic.

These soils are suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. They have no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings but are poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soils readily absorb but do not

adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification of both soils is IVe. The productivity index of the unit for spring wheat is 49. The range site of the Ulen soil is Limy Subirrigated, and that of the Hecla soil is Sands.

176B—Velva loam, 0 to 6 percent slopes. This deep, level to gently sloping, well drained soil is on flats and rises on bottom land and terraces. It is subject to occasional flooding. Individual areas range from 10 acres to more than 300 acres in size.

Typically, a cover of undecomposed stems, leaves, and roots is at the surface. The surface layer is very dark gray loam about 5 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown loam in the upper part, dark brown loam in the next part, and dark brown fine sandy loam in the lower part. The next layer is very dark grayish brown silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is dark brown loam. In some places the soil contains less sand and more clay. In other places the dark color of the surface layer extends to a depth of 16 inches or more.

Included with this soil in mapping are small areas of somewhat excessively drained soils and Ludden soils. These included soils make up about 5 percent of the unit. The somewhat excessively drained soils occur as areas intermingled with areas of the Velva soil. The poorly drained Ludden soils are in oxbows.

Permeability is moderately rapid in the Velva soil, and runoff is slow. Available water capacity and the organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. Some are used as range or hay. Flooding delays tillage and seeding in the spring of some years, but it does not prevent seeding of the common crops. This soil is suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are controlling scouring during flooding and controlling soil blowing. The hazard of soil blowing is moderate, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to control scouring and provides food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields because of the flooding. Better sites generally are nearby.

The land capability classification is IIe. The productivity index for spring wheat is 67. The range site is Sandy.

177—LaDelle silty clay loam, 0 to 3 percent slopes. This deep, level and nearly level, moderately well drained soil is on flats on bottom land and terraces. It is subject to occasional flooding. Individual areas range from 10 acres to more than 200 acres in size.

Typically, the surface soil is black silty clay loam about 20 inches thick. The subsoil is silty clay loam about 24 inches thick. It is very dark grayish brown and very dark gray in the upper part and is dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the soil contains more sand and less silt.

Included with this soil in mapping are small areas of the Ludden and Velva soils. These included soils make up about 10 percent of the unit. The poorly drained Ludden soils are in oxbows. The Velva soils have a loam surface layer and subsoil. They are on rises.

Permeability is moderately slow in the LaDelle soil, and runoff is slow. Available water capacity and the organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet. Tilth is fair.

Most areas are used for cultivated crops. Some are used as range or hay. This soil is well suited to small grain, flax, and sunflowers. Flooding delays tillage and seeding in the spring of some years, but it does not prevent seeding of the common crops. The main concerns in managing cultivated areas are maintaining or improving fertility and tilth, which can be achieved by using practices such as adding organic material to the

surface soil. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are big bluestem and porcupinegrass. Intermediate wheatgrass, smooth bromegrass, big bluestem, and alfalfa are suitable hay and pasture plants. No major problems affect the use of this soil for range or pasture.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil generally is unsuited to buildings and septic tank absorption fields. Better sites generally are nearby.

The land capability classification is IIc. The productivity index for spring wheat is 94. The range site is Overflow.

180—Wyndmere fine sandy loam, saline. This deep, level, somewhat poorly drained, highly calcareous, moderately saline soil is on flats on delta plains and lacustrine plains. Individual areas range from 5 acres to more than 150 acres in size.

Typically, the surface layer is black fine sandy loam about 9 inches thick. It has an accumulation of salts. The subsoil is fine sandy loam about 16 inches thick. It is very dark gray in the upper part and dark gray in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled fine sandy loam in the upper part and light olive brown, mottled loam in the lower part. In some places the subsoil and substratum are silt loam. In other places, the subsoil is loamy fine sand and the substratum is fine sand.

Included with this soil in mapping are small areas of the Arveson, Stirum, and Towner soils. These included soils make up about 5 percent of the unit. The poorly drained Arveson and Stirum soils are in shallow depressions. The moderately well drained Towner soils are on rises.

Permeability is moderately rapid in the Wyndmere soil, and runoff is slow. Available water capacity is low. The salts in the soil reduce the amount of water available to plants. The organic matter content is high. A seasonal high water table is at a depth of 2 to 4 feet. Tilth is good.

Most areas are used for cultivated crops. Because of salinity, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to salt-tolerant crops, such as hay, pasture, or range. A permanent cover of crops helps to control the accumulation of salts in the surface layer by reducing the evaporation rate at the surface. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass, inland saltgrass, and Nuttall alkaligrass. Alkali sacaton, tall wheatgrass, and sweetclover are suitable hay or pasture plants. The high content of salts, soil blowing, and the low available water capacity are problems, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable salt-tolerant plants helps to control soil blowing. Stock water ponds constructed in areas of this soil frequently contain salty water.

This soil is suited to only a few of the most salt-tolerant, climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs vary in height, density, and vigor. They are affected by the limited available water capacity caused by the salts in the soil. Reducing the evaporation rate at the surface improves seedling survival. When the bare surface dries, salt-laden water tends to move to the surface. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIs. The productivity index for spring wheat is 45. The range site is Saline Lowland.

181—Wyndmere fine sandy loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats on delta plains and lacustrine plains. Individual areas range from 5 acres to more than 250 acres in size.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsoil is fine sandy loam about 30 inches thick. It is light brownish gray in the upper part and brown and mottled in the lower part. The substratum to a depth of about 60 inches is brown, mottled fine sandy loam in the upper part and light olive brown, mottled loamy fine sand in the lower part. In some places, the subsoil is loamy fine sand and the substratum is fine sand. In other places they are silt loam.

Included with this soil in mapping are small areas of the Embden and Hecla soils and the saline Wyndmere soils. These included soils make up about 15 percent of the unit. The moderately well drained Embden and Hecla soils are on rises. The saline Wyndmere soils occur as areas intermingled with areas of this Wyndmere soil.

Permeability is moderately rapid in the Wyndmere soil, and runoff is slow. Available water capacity is moderate. The organic matter content is high. A seasonal high water table is at a depth of 2 to 5 feet. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent the planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; providing field windbreaks; and stripcropping help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay or pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. The seasonal high water table is a limitation in septic tank absorption fields, but it can be overcome by using a mound system. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 67. The range site is Limy Subirrigated.

184—Wyrene sandy loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats on delta plains and outwash plains. Individual areas range from 3 acres to more than 100 acres in size.

Typically, the surface soil is black sandy loam about 13 inches thick. The subsoil is mottled sandy loam about 15 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is olive brown gravelly coarse sand in the upper part and yellowish brown coarse sand in the lower part. In some places the subsoil is loamy coarse sand. In other places the surface soil and subsoil are loam.

Included with this soil in mapping are small areas of the Falsen, Marysland, and Verendrye soils. These included soils make up about 10 percent of the unit. The moderately well drained Falsen soils are on rises. The poorly drained Marysland and Verendrye soils are in depressions.

Permeability is rapid in the Wyrene soil, and runoff is slow. Available water capacity is low. The organic matter content is high. A seasonal high water table is at a depth of 3 to 5 feet. Tilth is good. The root zone is moderately deep because of the gravelly coarse sand and coarse sand substratum.

Most areas are used as range, pasture, or hay. Some are used for cultivated crops. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing.

Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IIIe. The productivity index for spring wheat is 48. The range site is Limy Subirrigated.

185—Karlsruhe coarse sandy loam. This deep, level, somewhat poorly drained, highly calcareous soil is on flats on delta plains and outwash plains. Individual areas range from about 3 acres to more than 300 acres in size.

Typically, the surface soil is coarse sandy loam about 11 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark gray loamy coarse sand about 4 inches thick. The subsoil is very dark grayish brown loamy coarse sand about 5 inches thick. The next layer is dark brown, mottled coarse sand about 10 inches thick. The substratum to a depth of about 60 inches is mottled coarse sand. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. In places the subsoil is sandy loam.

Included with this soil in mapping are small areas of the Falsen and Verendrye soils. These included soils make up about 15 percent of the unit. The moderately well drained Falsen soils are on rises. The poorly drained Verendrye soils are in depressions.

Permeability is rapid in the Karlsruhe soil, and runoff is slow. Available water capacity is low. The organic matter content is moderate. A seasonal high water table is at a depth of 2.5 to 5.0 feet. Tilth is good.

Most areas are used for cultivated crops, pasture, or hay. Some are used as range. Because of droughtiness, this soil is poorly suited to small grain, flax, and sunflowers. It is best suited to rye or winter wheat, which protects the surface against soil blowing in fall, winter, and spring and makes the best use of the moisture available early in the growing season. The main concerns in managing cultivated areas are overcoming droughtiness and controlling soil blowing. Wetness delays tillage and seeding in the spring of some years, but it does not prevent planting of the commonly grown crops. The hazard of soil blowing is severe, and that of water erosion is slight. Using a system of conservation tillage that includes leaving crop residue on the surface; providing annual buffer strips, such as strips of flax; stripcropping; and providing field windbreaks help to control soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Leaving tall stubble on the surface helps to overcome droughtiness by trapping snow.

In areas where this soil is used as range, the important forage plants are little bluestem and big bluestem. Tall wheatgrass, big bluestem, little bluestem, and birdsfoot trefoil are suitable hay and pasture plants. Soil blowing is a problem, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing.

This soil is suited to all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. It has no critical limitations. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of

this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

This soil is suited to buildings but is poorly suited to septic tank absorption fields. Installing a surface and foundation drainage system helps to prevent seepage into basements. Because of the rapid permeability, the soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Using a mound system helps to prevent this pollution. It also increases the depth to the seasonal high water table. The sides of shallow excavations, such as those of basements, tend to cave in unless they are shored.

The land capability classification is IVe. The productivity index for spring wheat is 48. The range site is Limy Subirrigated.

186—Williams loam, 0 to 3 percent slopes. This deep, level and nearly level, well drained soil is on flats on till plains. Individual areas range from 10 acres to more than 3,000 acres in size.

Typically, the surface layer is very dark brown loam about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil does not have an accumulation of clay.

Included with this soil in mapping are small areas of the Hamerly and Tonka soils. These included soils make up about 5 percent of the unit. The Hamerly soils are somewhat poorly drained and are on flats around depressions. They are highly calcareous. The poorly drained Tonka soils are in shallow depressions.

Permeability is moderately slow in the Williams soil, and runoff is slow. Available water capacity and the organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are maintaining or improving fertility and tilth, which can be achieved by using practices such as adding organic material to the surface layer. Water erosion and soil blowing are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass and needleandthread. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. No major hazards affect the use of this soil for range or pasture.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IIc. The productivity index for spring wheat is 84. The range site is Silty.

186B—Williams loam, 3 to 6 percent slopes. This deep, undulating, well drained soil is on rises on till plains. Individual areas range from about 5 to more than 500 acres in size.

Typically, the surface layer is very dark brown loam about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the dark color of the surface layer extends to a depth of more than 16 inches. In other places the subsoil does not have an accumulation of clay.

Included with this soil in mapping are small areas of the well drained Zahl soils on knobs and shoulder slopes. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Williams soil, and runoff is medium. Available water capacity and the organic matter content are high. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is controlling water erosion. The hazard of soil blowing is slight, and that of water erosion is moderate. Using a system of conservation tillage that leaves crop residue on the surface, stripcropping, and installing grassed waterways in areas where runoff concentrates help to control water erosion. Conservation tillage also helps to provide food

and cover for resident and migratory wildlife.

In areas where this soil is used as range, the important forage plants are western wheatgrass and needleandthread. Intermediate wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

This soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

This soil is suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification is IIe. The productivity index for spring wheat is 76. The range site is Silty.

187C—Williams-Zahl loams, 6 to 9 percent slopes. These deep, gently rolling, well drained soils are on till plains. The Williams soil is on side slopes. The Zahl soil is on knolls, ridges, and shoulder slopes. Individual areas range from 3 acres to more than 300 acres in size. They are 50 to 75 percent Williams soil and 20 to 50 percent Zahl soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical..

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the subsoil does not have an accumulation of clay.

Typically, the Zahl soil has a very dark grayish brown loam surface layer about 5 inches thick. The subsoil is dark grayish brown loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown loam.

Included with these soils in mapping are small areas of the very poorly drained Parnell soils in deep depressions. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Williams and Zahl soils, and runoff is medium. Available water capacity is high. The organic matter content is high in the Williams soil and moderate in the Zahl soil. Tilth is good in both soils.

Most areas are used for cultivated crops. These soils are suited to small grain and flax. The main concern in managing cultivated areas is controlling soil blowing and water erosion. The hazard of water erosion is severe on both soils. The hazard of soil blowing is moderate on the Zahl soil and slight on the Williams soil. Using a system of conservation tillage that includes leaving crop residue on the surface, installing grassed waterways in areas where runoff concentrates, providing field windbreaks, and stripcropping help to control water erosion and soil blowing. Conservation tillage also helps to provide food and cover for resident and migratory wildlife.

In areas where these soils are used as range, the important forage plants are needleandthread, western wheatgrass, and little bluestem. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Williams soil is suited to nearly all of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. The Zahl soil is suited only to the most drought-tolerant species. Optimum growth, survival, and vigor are unlikely on this soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings. Planting strips of an annual cover crop between the rows of trees and shrubs helps to control soil blowing and protect the seedlings from abrasion.

These soils are suited to buildings and septic tank absorption fields. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Williams soil is IIIe, and that of the Zahl soil is IVe. The productivity index of the unit for spring wheat is 48. The range site of the Williams soil is Silty, and that of the Zahl soil is Thin Upland.

188E—Zahl-Williams loams, 9 to 20 percent slopes. These deep, rolling and hilly, well drained soils are on dissected till plains and on moraines. The Zahl soil is on shoulder slopes and summits. The Williams soil is on side slopes. Individual areas range from 5 acres to more than 250 acres in size. They are 40 to 60 percent Zahl soil and 35 to 55 percent Williams soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Zahl soil has a very dark grayish brown loam surface layer about 5 inches thick. The subsoil is dark grayish brown loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown loam. In places the dark color of the surface layer extends to a depth of 3 inches or less.

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the dark color of the surface layer extends to a depth of more than 16 inches. In some areas the subsoil does not have an accumulation of clay.

Included with these soils in mapping are small areas of the somewhat poorly drained Hamerly soils on flats. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Zahl and Williams soils, and runoff is rapid. Available water capacity is high. The organic matter content is moderate in the Zahl soil and high in the Williams soil.

Most areas are used as range, pasture, or hay. Because of the slope and the severe hazard of water erosion, these soils generally are unsuited to cultivated crops. The important range forage plants are needleandthread, western wheatgrass, and little bluestem. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and alfalfa are suitable hay and pasture plants. Soil blowing and water erosion are hazards, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

The Williams soil is suited to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted on the Zahl soil if special treatment is applied, such as hand or scalp planting. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are poorly suited to buildings and septic tank absorption fields. The slope is a limitation affecting both uses, but it can be overcome by designing the buildings and absorption fields so that they conform to the natural slope of the land. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of both soils is VIe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Williams soil is Silty.

188F—Zahl-Max-Svea loams, 6 to 60 percent slopes. These deep, well drained soils are on dissected till plains. The moderately sloping to very steep Zahl soil is on shoulder slopes and summits. The moderately sloping to very steep Max soil is on side slopes. The moderately sloping and strongly sloping Svea soil is on foot slopes. Individual areas range from 5 acres to more than 400 acres in size. They are 40 to 60 percent Zahl soil, 15 to 30 percent Max soil, and 15 to 25 percent Svea soil. The three soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Zahl soil has a very dark grayish brown loam surface layer about 5 inches thick. The subsoil is dark grayish brown, calcareous loam about 15 inches thick. The substratum to a depth of about 60 inches is grayish brown loam. In some places the dark color of the surface layer extends to a depth of only 3 inches or less. In other places the subsoil is noncalcareous.

Typically, the Max soil has a very dark brown loam surface layer about 6 inches thick. The subsoil is loam about 31 inches thick. It is dark brown in the upper part, olive brown in the next part, and light olive brown in the lower part. The substratum to a depth of about 60 inches is light olive brown loam.

Typically, the Svea soil has a black loam surface layer about 9 inches thick. The subsoil is about 23 inches thick. It is very dark gray loam in the upper part and dark grayish brown clay loam in the lower part. The next layer is light olive brown loam about 13 inches thick. The substratum to a depth of about 60 inches is light olive brown loam.

Included with these soils in mapping are small areas of the Dickey, Sioux, and Stirum soils. These included soils make up about 10 percent of the unit. The Dickey and Sioux soils occur as areas intermingled with areas of the Zahl soil. The Dickey soils have a loamy fine sand surface layer. The Sioux soils have a very gravelly coarse sand substratum. The Stirum soils have a dense, alkali subsoil. They are on bottom land.

Permeability is moderately slow in all three soils. Runoff is very rapid on the Max and Zahl soils and medium on the Svea soil. Available water capacity is high. The organic matter content is moderate in the Zahl soil and high in the Max and Svea soils.

Most areas are used as range. Because of the slope and the severe hazard of water erosion, these soils generally are unsuited to cultivated crops. The important range forage plants are needleandthread, big bluestem, green needlegrass, western wheatgrass, and porcupinegrass. Soil blowing and water erosion are problems, especially if the range is overgrazed. Reestablishing vegetation is difficult in denuded areas. The slope limits the use of machinery. Maintaining an adequate cover of the important plants helps to control soil blowing and water erosion. Gullies can form along cattle trails. Using a planned grazing system that controls the pattern of livestock traffic helps to prevent gullying.

These soils generally are unsuited to trees and shrubs grown as windbreaks and environmental plantings. Trees and shrubs for esthetic or wildlife purposes can be planted if special treatment, such as hand or scalp planting, is applied.

Because of slope, these soils generally are not used as building sites or septic tank absorption fields. Better sites generally are nearby.

The land capability classification of the Zahl and Max soils is VIIe, and that of the Svea soil is IVe. The productivity index of the unit for spring wheat is 0. The range site of the Zahl soil is Thin Upland, and that of the Max and Svea soils is Silty.

189—Williams-Niobell loams, 0 to 3 percent slopes. These deep, level and nearly level soils are on till plains. The well drained Williams soil is on flats. The moderately well drained, alkali Niobell soil is in swales. Individual areas range from 5 acres to more than 150 acres in size. They are 40 to 60 percent Williams soil and 35 to 60 percent Niobell soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In some places the subsoil does not have an accumulation of clay. In other places the dark color of the surface layer extends to a depth of more than 16 inches.

Typically, the Niobell soil has a very dark brown loam surface layer about 7 inches thick. The next layer is dark brown and dark grayish brown loam about 7 inches thick. The subsoil is dense clay loam about 17 inches thick. It is dark brown in the upper part and olive brown in the lower part. The substratum to a depth of about 60 inches is olive, mottled loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Miranda soils in swales. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Williams soil and slow in the Niobell soil. Runoff is slow on both soils. Available water capacity and the organic matter content are high in both soils. Tilth is good in the Williams soil and fair in the Niobell soil. The root zone is shallow in the Niobell soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concern in managing cultivated areas is improving root penetration in the dense, alkali subsoil of the Niobell soil. Crops growing on this soil characteristically are stunted because of moisture stress. Soil blowing and water erosion are slight hazards. These limitations can be overcome by using a conservation tillage system that leaves crop residue on the surface. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue help to increase the rate of water infiltration, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Niobell soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and blue grama. Pubescent wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. No major hazards

affect the use of these soils for range or pasture.

The Williams soil is suited to nearly all and the Niobell soil to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs on the Niobell soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The Williams soil is better suited than the Niobell soil. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and basement walls help to prevent structural damage caused by shrinking and swelling. The slow and moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Williams soil is IIc, and that of the Niobell soil is IIIs. The productivity index of the unit for spring wheat is 76. The range site of the Williams soil is Silty, and that of the Niobell soil is Clayey.

189B—Williams-Niobell loams, 3 to 6 percent slopes. These deep, undulating soils are on till plains. The well drained Williams soil is on rises. The moderately well drained, alkali Niobell soil is in swales. Individual areas range from 5 acres to more than 150 acres in size. They are 40 to 70 percent Williams soil and 30 to 50 percent Niobell soil. The two soils occur as areas so intricately intermingled or so small that mapping them separately is not practical.

Typically, the Williams soil has a very dark brown loam surface layer about 5 inches thick. The subsoil is clay loam about 42 inches thick. It is dark brown in the upper part and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the subsoil does not have an accumulation of clay.

Typically, the Niobell soil has a very dark brown loam surface layer about 7 inches thick. The next layer is dark brown and dark grayish brown loam about 7 inches thick. The subsoil is dense clay loam about 17 inches thick. It is dark brown in the upper part and olive brown in the lower part. The substratum to a depth of about 60 inches is olive, mottled loam. In places the subsoil is very dense.

Included with these soils in mapping are small areas of the highly calcareous Zahl soils on knobs and knolls. These included soils make up about 5 percent of the unit.

Permeability is moderately slow in the Williams soil and slow in the Niobell soil. Runoff is medium on both soils. Available water capacity and the organic matter content are high in both soils. Tilth is good in the Williams soil and fair in the Niobell soil. The root zone is shallow in the Niobell soil because of the dense, alkali subsoil.

Most areas are used for cultivated crops. These soils are suited to small grain, flax, and sunflowers. The main concerns in managing cultivated areas are controlling water erosion and improving root penetration in the dense, alkali subsoil of the Niobell soil. Crops growing on this soil characteristically are stunted because of moisture stress. The hazard of soil blowing is slight, and that of water erosion is moderate. Using a system of conservation tillage that leaves crop residue on the surface, installing grassed waterways in areas where runoff concentrates, and stripcropping help to control water erosion. Conservation tillage also helps to provide food and cover for resident and migratory wildlife. Growing deep rooted crops, such as alfalfa, and managing crop residue increase the infiltration rate, improve or maintain tilth, and improve the penetration of roots in the dense, alkali subsoil of the Niobell soil.

In areas where these soils are used as range, the important forage plants are western wheatgrass, needleandthread, green needlegrass, and blue grama. Pubescent wheatgrass, crested wheatgrass, and alfalfa are suitable hay and pasture plants. Water erosion is a hazard, especially if the range or pasture is overgrazed. Maintaining an adequate cover of the important or suitable plants helps to control water erosion.

The Williams soil is suited to nearly all and the Niobell soil to many of the climatically adapted trees and shrubs grown as windbreaks and environmental plantings. Individual trees and shrubs on the Niobell soil vary in height, density, and vigor. They are affected by the restricted root development in the dense, alkali subsoil and the limited available water capacity caused by the salts in the soil. Eliminating grasses and weeds before the trees and shrubs are planted and then controlling the regrowth of this ground cover improve the survival and growth rates of the seedlings.

These soils are suited to buildings and septic tank absorption fields. The Williams soil is better suited than the Niobell soil. The shrink-swell potential is a limitation on building sites. Installing a surface and foundation drainage system and reinforcing foundations and

basement walls help to prevent structural damage caused by shrinking and swelling. The slow and moderately slow permeability is a limitation in septic tank absorption fields, but it can be overcome by enlarging the field.

The land capability classification of the Williams soil is IIe, and that of the Niobell soil is IIIe. The productivity index of the unit for spring wheat is 74. The range site of the Williams soil is Silty, and that of the Niobell soil is Clayey.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 297,000 acres in McHenry County, or nearly 24 percent of the total acreage, meets the soil requirements for prime farmland.

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

The following map units make up the prime farmland in McHenry County. If a soil is considered to be prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

1	Tonka silt loam (where drained)
24B	Barnes-Buse loams, 3 to 6 percent slopes
29	Svea-Barnes loams, 0 to 2 percent slopes
29B	Barnes-Svea loams, 2 to 5 percent slopes
50	Colvin silt loam (where drained)
56	Divide loam, 0 to 3 percent slopes
62B	Egeland fine sandy loam, 0 to 6 percent slopes
65	Embden fine sandy loam, 0 to 3 percent slopes
68	Fargo silty clay (where drained)
76	Gardena loam, 0 to 3 percent slopes
80	Glyndon loam
82	Great Bend-Overly complex, 0 to 3 percent slopes
89	Hamerly loam, 0 to 3 percent slopes
90	Hamerly-Tonka complex, 0 to 3 percent slopes (where drained)
124	Marysland silt loam (where drained)
157	Swenoda fine sandy loam, 0 to 3 percent slopes
158B	Swenoda-Barnes complex, 0 to 6 percent slopes
176B	Velva loam, 0 to 6 percent slopes
177	LaDelle silty clay loam, 0 to 3 percent slopes
181	Wyndmere fine sandy loam

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lyle Samson, agronomist, and Dennis D. Roscoe, soil conservationist, Soil Conservation Service, helped to prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 60 percent of McHenry County is cultivated. In 1984, 274,500 acres was used for close-grown crops, 120,000 acres for row crops, and 170,000 acres for forage crops *(9)*. The acreage of summer fallow was 165,000 in 1980, 135,000 in 1981, 120,000 in 1982, 130,000 in 1983, and 130,000 in 1984. The acreage used for sunflower production has fluctuated, but generally it is increasing (fig. 9). It averaged 74,400 acres per year from 1980 to 1984. It was 35,000 acres in 1980 and 68,000 acres in 1983. The acreage used for corn and forage has been relatively stable since 1980. In 1984 the acreages of the principal close-grown crops were as follows: spring wheat, 120,000 acres; durum wheat, 40,000 acres; winter wheat, 5,000 acres; barley, 45,000 acres; oats, 40,000 acres; rye, 12,500 acres; and flax, 12,000 acres. The main row crops were sunflowers and corn. Sunflowers were grown on 105,000 acres, corn for grain on 6,400 acres, and corn for silage on 8,100 acres. Alfalfa was grown on 70,000 acres and other hay crops on 100,000 acres. Small acreages were planted to mustard, rye, buckwheat, lentils, millet, and soybeans.

The potential of the soils in McHenry County for increased production of food and fiber is good. This production is steadily increasing as the latest crop production technology is applied. This soil survey can facilitate the application of this technology.

The soils and climate of the county are suited to most of the crops that are commonly grown in the

Figure 9.—Sunflowers in an area of Barnes-Svea loams, 2 to 5 percent slopes. These soils are well suited to cultivated crops.

survey area. Crops that are not commonly grown, but are suitable, include dry beans, potatoes, and rapeseed.

The principal management measures that help to ensure continuing productivity are those that control soil blowing and water erosion, maintain or improve fertility and tilth, and result in proper use of soil moisture.

Water erosion and soil blowing reduce the productivity of the soils. If the surface layer is lost, most of the available plant nutrients also are lost. As a result, applications of fertilizer are needed to maintain adequate crop production.

Of equal concern is the loss of organic matter through erosion. Soil structure, water infiltration, available water capacity, and tilth are all negatively affected by this loss. As organic matter is lost and the subsoil is exposed and tilled, the remaining soil becomes increasingly susceptible to both soil blowing and water erosion.

Soil blowing is a hazard on most of the soils in McHenry County. It is a severe hazard on the coarse textured and moderately coarse textured soils, including Arvilla, Aylmer, Bantry, Claire, Dickey, Egeland, Embden, Falsen, Fossum, Hecla, Karlsruhe, Larson, Letcher, Lohnes, Maddock, Minnewaukan, Serden, Sioux, Stirum, Swenoda, Towner, Ulen, Verendrye, Wyndmere, and Wyrene soils.

Arveson, Buse, Colvin, Divide, Glyndon, Hamerly, and Zahl soils and others that have a relatively high content of lime are susceptible to soil blowing in spring

if they have been bare throughout the winter. Because of freezing and thawing, soil structure breaks down, resulting in aggregates that are susceptible to movement. Nearly all soils can be damaged by soil blowing if they are bare.

Water erosion is a severe hazard on moderately sloping and steeper soils, such as those of the Barnes, Buse, Williams, and Zahl series. The hazard is greatest when the surface is bare.

Conservation practices that control both soil blowing and water erosion are those that maintain a protective cover on the surface. An example is using a conservation tillage system that keeps a protective amount of crop residue on the surface. Applications of approved herbicides can help to eliminate the need for summer fallow tillage. Cover crops are also effective in controlling both soil blowing and water erosion. Providing field windbreaks and annual wind barriers and stripcropping help to control soil blowing. Including grasses and legumes in the cropping system; installing grassed waterways, diversions, and terraces; contour farming; and field stripcropping across the slope help to control water erosion. Using a management system that includes several measures is the best means of protecting the soil. For example, conservation tillage can control soil blowing during years when the amount of crop residue is adequate, but windbreaks are needed during years when the amount of residue is low.

Moisture at planting time is critical to the success of crops during the growing season. In years when the amount of available soil moisture is low at planting time, crop success for the year is greatly reduced. Measures that conserve moisture include those that reduce evaporation and runoff rates, increase the rate of water infiltration, and control weeds. Examples are stubble mulch tillage; no-till; stripcropping; growing cover crops; managing crop residue; letting stubble stand, which traps snow; and applying fertilizer. When fallow is used to preserve moisture for the next season, a cover of crop residue is essential during winter to guard against moisture loss and erosion. Weed control helps to prevent depletion of the moisture supply.

Measures that improve fertility are needed on many soils. Examples are applying commercial fertilizer, growing green manure crops, including legumes in the cropping system, and applying barnyard manure.

Proper management of soils includes measures that maintain good tilth. These measures are especially needed on the Aberdeen, Cavour, Cresbard, Larson, Letcher, and Niobell soils that have an alkali subsoil and on the Fargo, Great Bend, and LaDelle soils that have a silty clay or silty clay loam surface layer. Measures that maintain the content of organic matter are very important if good tilth is to be maintained. The traditional practice of clean-tilled summer fallow contributes to the loss of organic matter because it increases susceptibility of the soils to erosion.

Management of Saline and Alkali Soils

Saline and alkali soils make up nearly 8 percent of McHenry County. Saline soils make up about 1 percent of the area, or about 16,000 acres; alkali soils make up about 3 percent, or about 40,000 acres; and saline-alkali soils make up about 4 percent, or about 54,000 acres.

Saline soils have a high concentration of soluble salts. The saline soils in McHenry County are in the Colvin, Glyndon, Hamerly, and Wyndmere series.

Saline soils generally develop in areas of restricted drainage, such as those adjacent to sloughs and waterways. Where drainage is poor, salts rise with the water table and are concentrated near the surface. This salt buildup is reduced by maintaining a surface cover of plants. The plant roots use the soil water before it can reach the surface and before the salts accumulate. The plant cover prevents evaporation at the surface, the upward movement of water in the soil, and the concentration of salts at the surface.

Plants growing on saline soils absorb salts from the soil water. Excess amounts of certain salts may interfere with plant growth. High concentrations of some salts are toxic to certain plants. Some salts cause nutritional imbalances or deficiencies by restricting the uptake or availability of certain plant nutrients. Detecting salinity by visual observations in the field is difficult. The salts generally are not visible during much of the growing season, particularly when the soil is moist. Flecks, threads, or masses of soluble salts commonly are visible when the soil is dry. Laboratory analysis is needed to determine the actual degree of salinity in the soils.

Crop response, particularly during periods of soil moisture stress, is a useful indicator of the degree of salinity in saline soils. For instance, a small grain growing on saline soils tends to be stunted and has fewer tillers than small grain on nonsaline soils. Strongly saline soils are best suited to native grasses or to salt-tolerant introduced grasses. Slightly saline or moderately saline soils can produce salt-tolerant crops and forage. Barley is the most salt tolerant of the small grains. Of the forage crops, tall wheatgrass, western wheatgrass, and alfalfa are salt tolerant once they have

become established. Continuous cropping is beneficial because it reduces evaporation and salt accumulation in the surface layer.

Alkali soils are characterized by a high content of exchangeable sodium, which adheres to the clay particles in the soil. The alkali soils in McHenry County are those of the Aberdeen, Cavour, Cresbard, Larson, Letcher, and Niobell series. Locally, alkali soils are known as "alkali," or "gumbo."

Alkali soils develop in a complex pattern and have a very distinct microrelief. The physical and chemical properties of these soils differ markedly within very short distances. In many areas the distance between the alkali soils and the surrounding soils that have normal physical properties is only a few feet, perhaps 5 to 10 feet.

Alkali soils develop in areas of saline soils that contain large quantities of sodium salts. Over a long period, usually centuries, as the water table drops, rain gradually leaches the salts from the surface to lower horizons. During this leaching process, the clay in the soil becomes saturated with sodium, disperses, and moves downward with the percolating water. As the moving clay concentrates, a dense, alkali subsoil forms. The dense subsoil is hard when dry, sticky when wet, and nearly impervious to roots, water, and air. Examples of soils that have a dense, alkali subsoil are those of the Cavour, Larson, and Letcher series.

As the leaching by soil water continues, the sodium is gradually moved lower in the soil profile and eventually is carried below the rooting depth. The result is more manageable soils, such as those of the Aberdeen, Cresbard, and Niobell series. If the leaching process continues and nearly all of the sodium is removed from the profile, the soil eventually changes into a nonalkali soil. This change requires a long period, usually centuries *(6)*.

If plowed, alkali soils are characterized by a surface layer that is sticky when wet and hard and cloddy when dry. A crust forms easily at the surface. The chemical and physical properties of these soils are unfavorable for plant growth. The harmful effects of the properties on plants generally increase as the sodium content increases. The effects of the reduced amount of water available to plants are more harmful than the toxic effect of the sodium. The plants also are affected by the depth to the dense subsoil.

Identification of alkali soils in cultivated fields commonly is difficult because many of the physical characteristics, such as columnar structure, have been altered by tillage. Crop response, particularly during periods of soil moisture stress, is a useful indicator of the level of alkalinity in a soil. Crops grown on soils with varying amounts of sodium exhibit varying heights and stages of development. If the level of alkalinity is very high, the crop cannot grow. The effects of sodium on crop growth are influenced by weather conditions, the stage of crop growth, and the soil moisture status. A measure of the effects of alkalinity on plant growth is not necessarily a reliable measure of crop yields. In many areas the yields of barley and wheat are affected less than the growth of these crops.

The variability of alkali soils can cause management problems. The soils that have a dense, alkali subsoil near the surface, such as those of the Cavour, Larson, and Letcher series, are better suited to grass than to small grain and sunflowers.

Timely tillage is an important management need in areas of leached alkali soils, such as those of the Aberdeen, Cresbard, and Niobell series. These areas should be tilled and seeded only when the moisture content is favorable. If worked when too wet, the soils puddle and crust. If the soils are tilled when too dry, tillage and seeding implements cannot easily penetrate them. Use of deep plowing and chemical amendments, where feasible, can help to reclaim alkali soils. To be effective, deep tillage should reach to the alkali subsoil and mix several inches of the underlying material with the subsoil and topsoil. Depending on the soil, tillage to a depth of 15 to 36 inches may be needed. Any reclamation of alkali soils is a long-term endeavor. Complete reclamation may never be achieved. Onsite investigation is needed to confirm the feasibility of deep tillage in a particular area.

Saline-alkali soils develop in areas of restricted drainage, where salts rise with the water table but where some leaching downward of clay and some saturation with sodium are evident and a dense, alkali subsoil has formed. The saline-alkali soils in McHenry County are those of the Harriet, Miranda, Ryan, and Stirum series. The management needs and crop responses on these soils are a combination of those on saline soils and those on alkali soils.

Additional information about management or reclamation of saline and alkali soils is available at offices of the Soil Conservation Service, the North Dakota Agricultural Experiment Station, and the Cooperative Extension Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table

because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Productivity Index

The productivity index is a relative rating of the ability of a particular map unit to produce a particular crop yield in comparison with other map units. The index ranges from 0, which indicates no yield, to 100, which indicates the highest yield. When the index is calculated, the similar and contrasting inclusions are considered as well as the soils specified in the name of the map unit. In McHenry County, a productivity index of 100 was considered to be equal to an average yield of 40 bushels per acre of spring wheat. Multiplying the productivity index by 40 and then dividing the product by 100 will convert the index number to a figure representing the expected average yield per acre. Svea-Barnes loams, 0 to 2 percent slopes, for example, has a productivity index of 88; when this is multiplied by 40 and then divided by 100, it converts to 35, which is the expected annual yield of spring wheat in bushels per acre for this map unit. (See table 5.)

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the

soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

By Jeffrey L. Prinz, soil conservationist, and Roy S. Mann, range conservationist, Soil Conservation Service.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

The native vegetation on rangeland consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Generally, the plants are suitable for grazing and the plant cover is sufficiently productive to justify grazing. Cultural treatments generally are not used to increase forage production. The composition and production of the plant community are determined by soil, climate, topography, overstory canopy, and grazing management.

In 1985 approximately 380,000 acres in McHenry County, or about 31 percent of the total acreage, was rangeland. In areas where it is properly managed, the rangeland is similar to the presettlement prairie of the late 1800's and early 1900's. Most of the rangeland is on loamy glacial till plains and moraines and on sandy lacustrine plains, delta plains, and outwash plains. Much of it occurs as hilly to very steep, well drained or excessively drained soils or as level and nearly level, moderately well drained to very poorly drained soils. The soils generally are unsuited or, at best, are poorly suited to cultivated crops.

In 1985 the farms and ranches in the county had about 72,000 head of cattle. Of that number, about 3,600 were milk cows *(9)*. Most of the ranches include a cow-calf operation. Some also include a yearling operation, which adds flexibility during periods of low or high forage production. On some ranches used as a cow-calf operation, sheep are raised for improved income stability.

Because of the relatively short growing season, many farmers and ranchers have established cool-season tame pastures to supplement the forage produced on rangeland and to extend the grazing season in spring and fall. Droughts of short duration are common. As a result, cool-season pastures cannot be grazed in fall in many years. Generally, large amounts of hay and feed are needed because of the long winters. Hay was harvested on about 170,000 acres in 1984 *(9)*.

Range Sites and Condition Classes

Soils vary in their capacity to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

Each range site has a distinctive potential plant community that is referred to as the climax vegetation. The climax vegetation is relatively stable and indicates what the range site is capable of producing. It reproduces itself annually and changes very little as long as the environment remains unchanged. On the prairie the climax vegetation consists of the kinds of plants that grew when the region was settled. It is generally the most productive combination of forage plants that can be grown on the site. When the site is improperly grazed, some of the climax vegetation decreases in proportion and some of it increases. Also, other plants that were not part of the native plant community invade the site.

Decreaser plants are the species that decline in quantity under close, continuous grazing. They generally are the tallest and most productive grasses and forbs and are the most palatable to livestock.

Increaser plants are the species that increase in quantity under close grazing at the expense of the decreaser species. They generally are the shorter plants or the ones less palatable to livestock.

Invader plants are species normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site only after the extent of the climax vegetation has been reduced by heavy, continual grazing. Most invader species have little value for grazing.

Range condition classes indicate the present composition of the plant community on a range site in relation to the climax vegetation. Range condition is expressed as excellent, good, fair, or poor, depending on how much the present plant community resembles the natural plant community. *Excellent* indicates that 76 to 100 percent of the present plant community is the same as the climax vegetation; *good*, 51 to 75 percent; *fair*, 26 to 50 percent; and *poor*, 25 percent or less.

Potential forage production depends on the kind of range site. Current forage production depends on the range condition and the amount of moisture available to the plants during the growing season.

Table 6 shows, for nearly all of the soils in the county, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as kind of plant, stage of growth, exposure, amount of shade, recent rains, and unseasonable dry periods.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good range management keeps the range in excellent or good condition. Water is conserved, yields are improved, and soils are protected. The main management concern is recognizing the changes in the plant community that take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall, for example, may lead to the conclusion that the range is in good condition, when actually the plant cover is weedy and the long-term trend is toward lower production. On the other hand, some rangeland that has been grazed closely for a short period may have a degraded appearance that temporarily obscures its quality and ability to recover rapidly.

Rangeland can recover from prolonged overuse if the decreaser species of the climax plant community have not been completely grazed out. If overgrazing is stopped, enough climax plants generally remain for proper management practices to restore the rangeland to an excellent condition. In areas where the climax plant community has been destroyed, range seeding can improve the condition. Seeding the proper climax species in areas of poor-quality cropland can restore its productivity as rangeland. Brush control, development of watering facilities, and other mechanical practices are needed to improve the potential of some rangeland. Proper fencing provides the opportunity to achieve good management of rangeland.

The following paragraphs describe the range sites in McHenry County. The names of these sites are Clayey, Claypan, Limy Subirrigated, Overflow, Saline Lowland, Sands, Sandy, Sandy Claypan, Shallow to Gravel, Silty, Subirrigated, Subirrigated Sands, Thin Claypan, Thin Sands, Thin Upland, Very Shallow, Wetland, and Wet Meadow.

Clayey range site. This site is dominated by a mixture of cool-season, mid grasses and an understory of short grasses. The principal mid grasses are western wheatgrass, porcupinegrass, needleandthread, and green needlegrass. The understory plants are blue grama, prairie junegrass, and Pennsylvania sedge and other upland sedges. Forbs, such as western yarrow, scarlet globemallow, and gray sagewort, make up about

5 percent of the total herbage. The common woody plants are fringed sagebrush, western snowberry, and prairie rose.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, porcupinegrass, needleandthread, green needlegrass, and prairie junegrass. The plants that increase under these conditions are blue grama, fringed sagebrush, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, western ragweed, and fringed sagewort or the invasion of Kentucky bluegrass.

Very few problems affect the management of this site. The water infiltration rate is slow. As a result, an adequate cover of vegetation is needed to help ensure that forage production is not reduced by runoff. Areas where the range is in fair condition can generally be restored to good or excellent condition by good management, if the remnant climax species remain on the site in sufficient numbers and are evenly distributed.

Claypan range site. The climax vegetation on this site is primarily a mixture of short and mid grasses, sedges, and forbs. The principal species are western wheatgrass, green needlegrass, needleandthread, and prairie junegrass. Other species are blue grama and upland sedges. The common forbs are scarlet globemallow, silver scurfpea, and rush skeletonplant. Fringed sagewort is a common shrub on this site.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and western wheatgrass. The plants that increase in abundance under these conditions are inland saltgrass, blue grama, Sandberg bluegrass, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, inland saltgrass, upland sedges, fringed sagebrush, broom snakeweed, and unpalatable forbs.

This site is easily damaged by overgrazing. Because of a dense subsoil and the content of salts in the soil, reestablishing the vegetation is difficult in denuded areas. Careful management that maintains the abundance of the naturally dominant plants is the best way to maintain forage production and protect the soil from water erosion.

Limy Subirrigated range site. Tall grasses dominate this site. The principal species are little bluestem, big bluestem, indiangrass, and switchgrass. Other species are slim sedge, fescue sedge, and Baltic rush. The common forbs are Maximilian sunflower, stiff sunflower, American licorice, and Missouri goldenrod. They make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, indiangrass, switchgrass, Maximilian sunflower, and stiff sunflower. Little bluestem initially increases in abundance under these conditions, but it eventually decreases. Further deterioration results in a dominance of Kentucky bluegrass, Baltic rush, and common spikerush and low-growing sedges, grasses, and forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or use of a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Overflow range site. Both tall and mid grasses are dominant when this site is in excellent condition. The principal species are big bluestem, green needlegrass, western wheatgrass, and needleandthread. Other species are porcupinegrass, switchgrass, fescue sedge, and little bluestem. Several forbs, such as Maximilian sunflower, soft goldenrod, gray sagewort, and heath aster, make up about 10 percent of the total herbage. Several woody plants, such as western snowberry, fringed sagebrush, and common chokecherry, commonly grow on the site. They may make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, green needlegrass, prairie dropseed, and switchgrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, Pennsylvania sedge, and fescue sedge. Further deterioration results in a dominance of blue grama, sedges, Kentucky bluegrass, and unpalatable forbs.

Because of its position on the landscape, this site frequently is overgrazed. Separate fencing of areas of this site generally is not feasible because of the small size or the shape of the areas. As a result of flooding and the runoff received by these areas, they are very productive when properly managed. Using a planned grazing system can restore the site and maintain a high level of productivity. Seeding is needed in areas that have been farmed. In areas where shrubs dominate, brush control can help to restore productivity.

Saline Lowland range site. Salt-tolerant, mid grasses dominate this site. The principal species are Nuttall alkaligrass, inland saltgrass, alkali cordgrass, western wheatgrass, and slender wheatgrass. Other species are alkali muhly, plains bluegrass, foxtail barley, and prairie bulrush. Forbs, such as western dock, silverweed cinquefoil, and Pursh seepweed, make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as Nuttall alkaligrass, slender wheatgrass, western wheatgrass, and alkali cordgrass. The plants that increase in abundance under these conditions are inland saltgrass, alkali muhly, foxtail barley, and mat muhly. Further deterioration results in a dominance of inland saltgrass, foxtail barley, silverweed cinquefoil, and western dock.

A high content of salts and a restricted available water capacity limit forage production on this site. Careful management of the adapted, desirable, salt-tolerant plants can maintain good forage production. If the plant community has been severely damaged, however, the site recovers slowly. Soil blowing and water erosion are hazards in denuded areas. Stock water ponds on this site frequently contain salty water. If feasible, alternative water sources should be developed.

Sands range site. The principal grasses on this site are prairie sandreed, needleandthread, sand bluestem, and sand dropseed. Other species are blue grama, prairie junegrass, little bluestem, sand dropseed, western wheatgrass, and upland sedges. Forbs make up about 10 percent of the total herbage. This site has a small amount of woody species, such as prairie rose, western snowberry, and leadplant amorpha.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, little bluestem, sand bluestem, and leadplant amorpha. The plants that increase in abundance under these conditions are sand dropseed, blue grama, upland sedges, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as fringed sagewort and gray sagewort.

A low or very low available water capacity and a hazard of soil blowing are concerns in managing this site. Measures that minimize the formation of livestock trails and that do not allow the animals to concentrate in an area for too long a time are needed. In severely overgrazed areas, blowouts are common. On large blowouts, shaping, seeding, and mulching are needed before the climax vegetation can be reestablished. The vegetation in areas where the site is in fair or poor condition responds rapidly to improved grazing management.

Sandy range site. The principal grasses on this site are needleandthread and prairie sandreed. Other species are prairie junegrass, blue grama, western wheatgrass, and green needlegrass and upland sedges. The site generally has a number of early season forbs, such as western yarrow, green sagewort, and Missouri goldenrod. Woody plants, such as western snowberry and leadplant amorpha, make up about 5 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, green needlegrass, prairie sandreed, and leadplant amorpha. The plants that increase in abundance under these conditions are blue grama, upland sedges, sand dropseed, and several forbs. Further deterioration results in a dominance of blue grama, upland sedges, and unpalatable forbs, such as western yarrow, green sagewort, and gray sagewort.

A moderate available water capacity is a concern in managing this site. Also, soil blowing is a hazard in denuded areas. Management that maintains the abundance of the key species results in a natural plant community that provides excellent forage for livestock and a protective plant cover.

Sandy Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, needleandthread, and blue grama. Other species are sun sedge and other upland sedges and a small number of perennial forbs. The common woody plants are silver sagebrush, fringed sagebrush, and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass and needleandthread. The plants that increase in abundance under these conditions are blue grama, upland sedges, and fringed sagebrush. Further deterioration results in a dominance of blue grama, upland sedges, fringed sagebrush, annual forbs, and annual grasses.

Forage production varies on this site. The soils have a dense, alkali subsoil and a limited available water capacity. The site is fragile, and the natural plant community can deteriorate rapidly. Management that maintains a protective plant cover is needed to control erosion.

Shallow to Gravel range site. A mixture of cool- and warm-season, mid grasses dominates this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are plains muhly, prairie junegrass, red threeawn, and porcupinegrass and upland sedges. Forbs make up about 10 percent of the total herbage. The site has only a small amount of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, western wheatgrass, plains muhly, and prairie junegrass. The plants that increase in abundance under these conditions are blue grama, red threeawn, and upland sedges. Further deterioration results in a dominance of blue grama, upland sedges, Kentucky bluegrass, unpalatable forbs, and fringed sagebrush.

Because of a limited available water capacity, forage production is limited on this site. It varies, depending on rainfall patterns. The site is fragile, and the plant community can deteriorate rapidly. Because of the limited amount of available water, the plant community should be kept near its potential and in a state of high vigor in order to optimize available moisture use.

Silty range site. Mid grasses dominate this site. The principal species are western wheatgrass, needleandthread, green needlegrass, and blue grama. Other species are prairie junegrass, prairie dropseed, and upland sedges. Forbs make up about 10 percent of the total herbage. The site has minor amounts of woody species.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as green needlegrass, prairie junegrass, needleandthread, and porcupinegrass. The plants that increase in abundance under these conditions are western wheatgrass, blue grama, threadleaf sedge, needleleaf sedge, and fringed sagebrush. Further deterioration results in a dominance of blue grama, threadleaf sedge, needleleaf sedge, and Kentucky bluegrass and varying amounts of fringed sagebrush, gray sagewort, and other forbs.

Generally, no major problems affect the management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Subirrigated range site. Tall grasses dominate this site. The principal species are big bluestem, switchgrass, prairie cordgrass, little bluestem, and northern reedgrass. Other species are indiangrass, western wheatgrass, tall dropseed, and slender wheatgrass. The site has minor amounts of sedges and rushes. A variety of forbs makes up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, prairie cordgrass, northern reedgrass, indiangrass, and little bluestem. The plants that increase in abundance under these conditions are mat muhly, fowl bluegrass, Baltic rush, and common spikerush and undesirable forbs. Further deterioration results in a dominance of Kentucky bluegrass, short grasses, and grasslike plants and undesirable forbs.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season or use of a planned grazing system can restore the site. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species.

Subirrigated Sands range site. Tall and mid grasses dominate this site. The principal species are switchgrass and big bluestem. Other species are porcupinegrass, mat muhly, and prairie cordgrass. The site has minor amounts of sedges and rushes. A variety of forbs make up about 10 percent of the total herbage. Shrubs and trees, principally buckbrush and quaking aspen, make up an additional 15 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as big bluestem, switchgrass, porcupinegrass, and Maximilian sunflower. The plants that increase in abundance under these conditions are sedges, undesirable forbs, and quaking aspen. Kentucky bluegrass is a common invader on this site. When the canopy of quaking aspen approaches 100 percent, only an understory of sedges and shrubs remains.

Because of the high percentage of warm-season grasses, this site can provide high-quality forage late in the growing season. In areas where the plant community has deteriorated from its potential, deferment of grazing during the growing season and

removal of the brush and trees can help to restore the site. The combination of grasses, sedges, forbs, shrubs, and trees provides a variety of wildlife habitat and lends variety and fall color to the landscape. Because of the wide variation in canopy cover, individual areas of this site may vary widely in grazeable herbage. In areas where the potential plant community has been destroyed by cultivation or by extremely severe overuse, range seeding can reestablish the major grass species. Soil blowing is a concern. It can be controlled by reestablishing the major grasses and by preventing the concentration of livestock in an area for too long a time.

Thin Claypan range site. Short grasses dominate this site. The principal species are western wheatgrass, blue grama, inland saltgrass, and Sandberg bluegrass. Other species are prairie junegrass, needleandthread, Nuttall alkaligrass, alkali muhly, and needleleaf sedge. Forbs make up about 5 percent of the total herbage. The common woody plants are fringed sagebrush and cactus.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as western wheatgrass, prairie junegrass, and needleandthread. Plants that increase in abundance under these conditions are blue grama, inland saltgrass, Sandberg bluegrass, and alkali muhly. Further deterioration results in a dominance of short grasses, sedges, fringed sagebrush, broom snakeweed, and undesirable forbs.

Because of a high content of salts near the surface, productivity is quite low on this site. The site produces good-quality forage for cattle only if properly managed. If the site is in poor or fair condition, recovery is quite slow because of the salts and a dense, alkali subsoil. Stock water ponds should not be constructed on this site because the water is likely to be salty. Careful management can maintain or restore the site to good or excellent condition. If the vegetation has been destroyed by cultivation or the site has been denuded, range seeding can restore the climax vegetation. Good seeding techniques are needed.

Thin Sands range site. Mid grasses dominate this site. The principal species are prairie sandreed, needleandthread, and sand bluestem. Other species are blue grama, sand dropseed, upland sedges, and prairie junegrass. Forbs make up about 10 percent of the total herbage. The site has minor amounts of woody plants.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as prairie sandreed, needleandthread, and sand bluestem. The plants that increase in abundance under these conditions are sand dropseed and upland sedges. Further deterioration results in a dominance of upland sedges, Kentucky bluegrass, blue grama, and several unpalatable forbs.

This site is very fragile. It is subject to soil blowing if the vegetation is damaged by overgrazing or the soil is denuded. Blowouts are common in overgrazed areas. Good management can keep the site in good or excellent condition. In areas where the site is in poor or fair condition, careful management can restore productivity. Using a planned grazing system that includes adequate rest periods between the grazing periods is one of the better ways of managing this site.

Thin Upland range site. Mid, cool- and warm-season grasses dominate this site. The principal species are little bluestem, needleandthread, western wheatgrass, and blue grama. Other species are plains muhly, sideoats grama, and red threeawn and upland sedges. Forbs make up about 10 percent of the herbage. The site has minor amounts of woody plants, such as silverberry and western snowberry.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as little bluestem, needleandthread, western wheatgrass, and sideoats grama. The plants that increase in abundance under these conditions are blue grama, red threeawn, upland sedges, and unpalatable forbs. Further deterioration results in a dominance of blue grama, Kentucky bluegrass, upland sedges, and fringed sagebrush.

Generally, no major problems affect the management of this site. In the more sloping areas, however, gullies can form along livestock trails. Fencing and improved grazing management help to prevent gullying. They are also beneficial in areas where gullies have already formed. Soil blowing is a problem in denuded areas. Areas where the site is in fair condition generally can be restored to good or excellent condition by good management. In some areas brush control is needed.

Very Shallow range site. This site has a mixture of cool- and warm-season, mid grasses. The principal species are needleandthread, western wheatgrass, blue grama, and plains muhly. Other species are prairie junegrass, red threeawn, and sideoats grama and upland sedges. Forbs and woody plants make up about 10 percent of the total herbage.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as needleandthread, western wheatgrass, sideoats grama,

and plains muhly. The plants that increase in abundance under these conditions are blue grama, red threeawn, and sand dropseed and upland sedges. Further deterioration results in a dominance of blue grama, red threeawn, upland sedges, and undesirable forbs and shrubs.

Available water capacity is very low on this site. Also, water erosion is a hazard in the more sloping areas. Gullies can form readily along cattle trails and in denuded areas. The site is frequently overgrazed. Once it is in fair or poor condition, it recovers slowly because of the very low available water capacity. Productivity can be maintained by careful management of the cool-season, mid grasses and by cross fencing, which helps to control livestock traffic patterns.

Wetland range site. Tall grasses dominate this site. The principal species are rivergrass, prairie cordgrass, northern reedgrass, slough sedge, and slim sedge. Other species are American mannagrass, American sloughgrass, Baltic rush, and common spikesedge. Common forbs are longroot smartweed and waterparsnip.

Continual heavy grazing by cattle results in a decrease in the abundance of such plants as rivergrass, slough sedge, prairie cordgrass, and northern reedgrass. The plants that increase in abundance under these conditions are slim sedge, Baltic rush, common spikesedge, and American sloughgrass. Further deterioration results in a dominance of Baltic rush, common spikesedge, and Mexican dock.

This site is easily damaged when it is wet. Grazing during wet periods results in soil compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. Use of a planned grazing system and deferment of grazing when the site is wet help to maintain the climax vegetation and maintain the important wetland wildlife value.

Wet Meadow range site. Mid sedges dominate this site. The principal species are slim sedge, wooly sedge, fescue sedge, prairie cordgrass, and northern reedgrass. Other species are Baltic rush, common spikerush, fowl bluegrass, and switchgrass. Common forbs are Rydberg sunflower, tall white aster, and common wild mint.

Continual heavy grazing by cattle results in a decrease in the abundance of slim sedge, wooly sedge, northern reedgrass, prairie cordgrass, and switchgrass. The plants that increase in abundance under these conditions are fescue sedge, common spikerush, Baltic rush, mat muhly, and fowl bluegrass. Further deterioration results in a dominance of low-growing sedges, short grasses, western dock, and Canada thistle.

This site is easily damaged when it is wet. Grazing during wet periods results in compaction, trampling, and root shearing. Livestock are attracted to this site because of the supply of moisture. Use of a planned grazing system with proper fencing helps to maintain the climax vegetation. The site is well suited to quality hay.

Woodland, Windbreaks, and Environmental Plantings

By Bruce C. Wight, forester, Soil Conservation Service.

McHenry County has about 14,300 acres of native woodland. Most of this woodland is on bottom land adjacent to the Souris River and in woody draws in its tributaries, in the sand hills in the northeastern part of the county, and on the fringe of some wetlands. The woodland on the Souris River bottom land is primarily on Ludden clay, LaDelle silty clay loam, and Velva loam. The woodland in the woody draws is primarily on Max loam and Svea loam. The woodland in the sand hills area is primarily on Aylmer and Bantry fine sands and on Serden sand. The woodland on the fringe of the wetlands is mostly on Tonka silt loam.

The bottom-land forest type consists primarily of American elm and green ash. Other less common species include boxelder, bur oak, cottonwood, common chokecherry, currant, dogwood, juneberry, and Woods rose. In the woody draws the primary tree species is green ash with American plum, boxelder, common chokecherry, hawthorn, and western snowberry. The sand hills area has quaking aspen and various willow species in the depressional areas, with dogwood, common chokecherry, and Woods rose associated with them. On the northeast aspects of the sand hills, the most common tree is bur oak. In some areas hackberry and American elm are also present. On the fringe of the wetlands, quaking aspen and various willow species are most common. Bog birch, which is uncommon in North Dakota, has been identified in a bog in the Denbigh area.

Early settlers used the trees for fuel, lumber, and fenceposts. Currently there is a renewed interest in using trees for fuel. The principal use of trees, however, is for protection and esthetic purposes. The trees protect the soil, homes, livestock, wildlife, and watersheds.

Windbreaks have been planted in McHenry County since the early days of settlement. Most of the early

plantings were made to protect farmsteads and livestock. In the 1930's, approximately 570 acres was planted to trees and shrubs under the Prairie States Forestry Project of the United States Department of Agriculture, Forest Service. Also at this time, the Forest Service started the Denbigh Experimental Forest on 640 acres of sandy land southwest of Towner. Most of this area was planted with emphasis on evergreens. The information gathered from this experimental forest has been used to improve the establishment of trees throughout North Dakota and the northern Great Plains.

Since the 1930's, more than 6,000,000 trees have been planted on about 9,500 acres by county farmers and landowners with the assistance of the Soil Conservation Service and the North McHenry County and South McHenry County Soil Conservation Districts. Trees and shrubs are still needed around numerous farmsteads, but the major need is for windbreaks that help to protect soils that are highly susceptible to soil blowing.

The following items should be considered before a planting is made: (1) the purpose of the planting, (2) the suitability of the soils, (3) the adaptability of the various species of trees and shrubs, (4) the location and design of the windbreak, and (5) the selection of a source of hardy and adapted trees and shrubs. If these items are not considered, a poor or unsuccessful windbreak may result.

The establishment of a windbreak or an environmental planting and the growth of the trees and shrubs also depend on suitable site preparation and adequate maintenance after the trees and shrubs are planted. Grasses and weeds should be eliminated before the planting is made, and regrowth of competing vegetation should be controlled for the life of the planting. Some replanting of the trees and shrubs may be necessary during the first 2 years after planting.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

By David D. Dewald, biologist, Soil Conservation Service.

The recreational resource in McHenry County is mainly based on hunting and fishing opportunities. Along with fishing, area lakes have picnicking facilities and Buffalo Lodge Lake has limited camping facilities. Limited camping facilities are also located in the Vagabond Forest, north of Towner. Eight towns in the county have picnicking and limited camping facilities in their local parks.

The J. Clark Slayer National Wildlife Refuge offers an important recreational resource to the survey area. About 37,000 acres of the refuge are located in McHenry County. The refuge offers public fishing; limited hunting of big game, upland game, and waterfowl; picnicking; observation towers for bird watching; auto trails; canoe trails; and hiking. Also available for similar public use are about 3,900 acres of waterfowl production areas; approximately 500 acres of State wildlife management areas; about 22,200 acres of land administered by the Department of University and School Lands, located in scattered tracts; and numerous other small tracts of land administered by the Bureau of Land Management. Public access is also available on the Denbigh Experimental Forest for hiking, cross-country skiing, and visiting an arboretum. One hunting preserve is located in the county, near Towner.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is also considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines.

The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils are gently sloping and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

By David D. Dewald, biologist, Soil Conservation Service.

Fish and wildlife resources are an important part of the social and economic aspects of McHenry County. They contribute significantly to the social well-being of the residents and visitors to the survey area.

Quality and quantity of habitat varies within the county. About 37,000 acres of the J. Clark Slayer National Wildlife Refuge, located in the northeastern part of the county, provides excellent habitat for migratory waterfowl and resident wildlife species. The United States Fish and Wildlife Service also manages an additional 3,900 acres for waterfowl. Approximately 500 acres is managed for wildlife by the North Dakota Game and Fish Department.

Landowners throughout the survey area have protected about 23,000 acres of wetland basins by conveying their drainage rights to the Federal government through the Small Wetlands Acquisition Program. Private landowners also manage about 48,000 acres of uplands and wetlands primarily for wildlife *(16)*. This acreage does not include the Federal Water Bank Program. As use of no-till and conservation tillage increases in the survey area, additional food and cover becomes available for resident and migratory waterfowl.

An important wildlife habitat resource in the county is the soils in basins that produce vegetation associated with wetlands. These areas are vital to the production of waterfowl and provide habitat for white-tailed deer, furbearers, and many nongame species of birds and mammals (fig. 10). Periodic spring flooding of the Souris River also provides early spring feeding and stop-over areas for migratory waterfowl.

Wildlife populations have declined since the survey area was settled because intensive cropping, wetland drainage, and year-long grazing of the county's remaining rangeland have reduced the quality and quantity of wildlife habitat.

Important game bird species in the survey area include gray partridge, sharp-tailed grouse, ring-necked pheasant, turkey, geese, ducks, mourning doves, and sandhill cranes. Mammals that are trapped or hunted include red fox, coyote, white-tailed deer, beaver, muskrat, mink, raccoon, badger, tree squirrels, cottontail

Figure 10.—An area of Southam silt loam. The ponded water and hydrophytic vegetation provide excellent habitat for wetland wildlife.

rabbit, and white-tailed jackrabbit.

In 1984 about 14 percent of the residents of the county purchased general game licenses and 6 percent purchased furbearer licenses. Fishing licenses were purchased by about 25 percent of the residents.

A wide variety of fish is available in the survey area. Northern pike, yellow perch, walleyed pike, bluegill, and rainbow trout are the major species fished. Fishing is available at Cottonwood Lake, Velva Sportsman's Dam, Buffalo Lodge Lake, J. Clark Slayer National Wildlife Refuge, George Lake, and Round Lake. Fishing is also available on the Souris River and the Deep River. Potential for developing additional fishing resources is limited.

About 192,000 acres, or nearly 16 percent, of McHenry County meets the requirements of soils with hydric conditions. The hydric conditions are evident or present unless the soils have been artificially drained or otherwise altered to such a degree that they no longer support a predominance of hydrophytic vegetation. The soil maps do not identify drained areas. The following list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4, and the location is shown on the detailed maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The map units in the survey area that generally exhibit hydric conditions are as follows:

1	Tonka silt loam
2	Parnell silty clay loam
5	Southam silt loam
6	Rifle mucky peat
19B	Aylmer-Minnewaukan complex, 0 to 6 percent slopes (Minnewaukan part)
50	Colvin silt loam
51	Colvin silt loam, saline
52	Colvin silt loam, wet
68	Fargo silty clay
72	Verendrye loamy coarse sand
73	Fossum and Arveson soils
74	Fossum fine sandy loam, wet
90	Hamerly-Tonka complex, 0 to 3 percent slopes (Tonka part)
104	Colvin silt loam, channeled
110	Ludden clay, ponded
111	Ludden clay
124	Marysland silt loam
136	Ryan loam
137	Harriet silt loam
151	Stirum fine sandy loam

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are intermediate and tall wheatgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, western wheatgrass, and blue grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are common chokecherry, buffaloberry, snowberry, and juneberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, common reed, saltgrass, prairie cordgrass, bulrush, and sedges.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow

water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, western meadowlark, lark bunting, cottontail, and red fox.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include deer, sharp-tailed grouse, western meadowlark, and David's sparrow.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are

required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1

or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate

shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment.

Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are

indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet

and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years;

and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the North Dakota State Highway Department Laboratory.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(14)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boroll (*Bor*, meaning cool, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haploborolls (*Hapl*, meaning minimal horizonation, plus *boroll*, the suborder of the Mollisols that has a frigid temperature regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Udic* identifies the subgroup that has an udic moisture regime. An example is Udic Haploborolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed Udic Haploborolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (13)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (14)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aberdeen Series

The Aberdeen series consists of deep, moderately well drained, slowly permeable, alkali soils on lacustrine

plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 2 percent.

Typical pedon of Aberdeen silt loam, in an area of Aberdeen-Great Bend complex, 0 to 3 percent slopes, 45 feet south and 100 feet east of the northwest corner of sec. 10, T. 159 N., R. 76 W.

Ap—0 to 5 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; neutral; abrupt smooth boundary.

B/E—5 to 10 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silt loam, dark gray (10YR 4/1) dry (B) and grayish brown (10YR 5/2) dry (E); weak medium prismatic structure parting to weak fine subangular blocky; hard, firm, sticky and plastic; common very fine roots; mildly alkaline; clear wavy boundary.

Bt—10 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard, firm, sticky and plastic; few very fine roots; continuous distinct clay films on faces of peds and in pores; common black (10YR 2/1) organic coatings on faces of peds; moderately alkaline; clear wavy boundary.

Btk—18 to 23 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; moderate medium and coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, sticky and plastic; few very fine roots; many distinct clay films on faces of peds and in pores; common fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; clear wavy boundary.

Bk—23 to 38 inches; light olive brown (2.5Y 5/4) silty clay loam, light gray (2.5Y 7/2) dry; weak coarse and medium subangular blocky structure; slightly hard, firm, sticky and plastic; few very fine roots; many fine irregular shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—38 to 51 inches; very dark grayish brown (2.5Y 3/2) silty clay, light brownish gray (2.5Y 6/2) dry; common fine faint olive brown (2.5Y 4/4) mottles; massive; hard, very firm, very sticky and very plastic; slightly effervescent; moderately alkaline; gradual smooth boundary.

Cyg—51 to 60 inches; dark olive gray (5Y 3/2) silty clay, olive gray (5Y 5/2) dry; common fine faint dark gray (5Y 4/1) and few fine distinct olive brown (2.5Y 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; slightly effervescent; many fine and medium masses of gypsum crystals; mildly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The B/E horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 3. It is silty clay or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 2 to 4. It is silty clay or silty clay loam.

Arveson Series

The Arveson series consists of deep, poorly drained, moderately rapidly permeable, highly calcareous soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Arveson loam, in an area of Fossum and Arveson soils, 2,640 feet north and 1,100 feet west of the southeast corner of sec. 32, T. 155 N., R. 78 W.

Ak—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine pores; disseminated lime throughout; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Bk1—8 to 17 inches; dark gray (N 4/0) loam, light gray (N 6/0) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine pores; disseminated lime throughout; violently effervescent; moderately alkaline; clear irregular boundary.

Bk2—17 to 29 inches; dark gray (N 4/0) loam, light gray (N 6/0) dry; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common very fine roots; disseminated lime throughout; strongly effervescent; moderately alkaline; clear wavy boundary.

Ab—29 to 35 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; few fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; slightly effervescent; mildly alkaline; clear smooth boundary.

C—35 to 60 inches; grayish brown (2.5Y 5/2) sand, light

gray (2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles and many medium and fine distinct gray (5Y 5/1) mottles; single grain; loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 6 dry). The Bk horizon has hue of 2.5Y or 5Y, or it is neutral in hue. Value is 4 to 6 (4 to 8 dry), and chroma is 0 to 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (5 to 7 dry), and chroma of 1 or 2. It is fine sand, sand, or fine sandy loam. Some pedons do not have an Ab horizon.

Arvilla Series

The Arvilla series consists of deep, somewhat excessively drained soils on outwash plains. Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Arvilla sandy loam, 0 to 6 percent slopes, 2,540 feet south and 1,200 feet west of the northeast corner of sec. 8, T. 157 N., R. 80 W.

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; clear smooth boundary.

Bw—7 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; clear smooth boundary.

2Bk—13 to 15 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; moderate medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; about 5 percent gravel; disseminated lime throughout; strongly effervescent; neutral; gradual wavy boundary.

2C—15 to 60 inches; dark brown (10YR 3/3) gravelly coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 25 percent gravel; strongly effervescent; mildly alkaline.

The depth to sand and gravel ranges from 14 to 25 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (3 to 5 dry), and chroma of 1 to 3. The gravel content of the 2C horizon ranges from 20 to 35 percent.

Aylmer Series

The Aylmer series consists of deep, moderately well drained, rapidly permeable soils on windblown delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Aylmer fine sand, in an area of Aylmer-Bantry fine sands, 0 to 6 percent slopes, 2,400 feet west and 650 feet south of the northeast corner of sec. 16, T. 159 N., R. 77 W.

A—0 to 3 inches; black (10YR 2/1) fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; loose, nonsticky and nonplastic; many fine and medium roots; neutral; clear smooth boundary.

C1—3 to 26 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; single grain; loose, nonsticky and nonplastic; common fine and medium roots; neutral; gradual wavy boundary.

C2—26 to 38 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; many medium distinct yellowish brown (10YR 5/4) mottles; single grain; loose, nonsticky and nonplastic; few fine and medium roots; neutral; clear wavy boundary.

Ab—38 to 43 inches; black (10YR 2/1) fine sand, dark gray (10YR 4/1) dry; many fine prominent reddish brown (5YR 4/3) mottles; single grain; loose, nonsticky and nonplastic; few fine and medium roots; slightly acid; clear wavy boundary.

C'1—43 to 56 inches; grayish brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky and nonplastic; few fine and medium roots; slightly acid; gradual wavy boundary.

C'2—56 to 60 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (10YR 6/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky and nonplastic; slightly acid.

The depth to mottles ranges from 20 to 40 inches. The depth to the Ab horizon also ranges from 20 to 40 inches.

The A horizon has value of 2 to 4 (3 to 5 dry) and chroma of 1 or 2. The C horizon has hue of 10YR or

2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is fine sand or sand. Some pedons do not have an Ab horizon.

Bantry Series

The Bantry series consists of deep, somewhat poorly drained, rapidly permeable soils on windblown delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Bantry fine sand, in an area of Aylmer-Bantry fine sands, 0 to 6 percent slopes, 1,455 feet south and 180 feet west of the northeast corner of sec. 33, T. 158 N., R. 76 W.

A—0 to 4 inches; black (10YR 2/1) fine sand, dark gray (10YR 4/1) dry; common fine prominent dark yellowish brown (10YR 3/6) mottles; weak medium subangular blocky structure; loose, nonsticky and nonplastic; few medium and many fine and very fine roots; slightly acid; clear smooth boundary.

C1—4 to 16 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; common medium and coarse distinct dark yellowish brown (10YR 4/6) mottles; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; slightly acid; clear smooth boundary.

C2—16 to 25 inches; dark grayish brown (2.5Y 4/2) fine sand, light gray (2.5Y 7/2) dry; many coarse prominent dark yellowish brown (10YR 4/6) mottles; single grain; loose, nonsticky and nonplastic; few fine roots; neutral; abrupt smooth boundary.

C3—25 to 40 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; many medium prominent dark yellowish brown (10YR 3/4) mottles; single grain; loose, nonsticky and nonplastic; few fine roots; neutral; clear wavy boundary.

C4—40 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand, grayish brown (2.5Y 5/2) dry; common medium prominent dark yellowish brown (10YR 3/6) mottles and common coarse faint grayish brown (2.5Y 5/2) mottles; single grain; loose, nonsticky and nonplastic; few fine roots; neutral.

The depth to mottles ranges from 0 to 20 inches. The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is fine sand or sand. Some pedons are calcareous in the lower part of the C horizon. Some pedons have an Ab horizon. Others have an AC horizon.

Barnes Series

The Barnes series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 25 percent.

Typical pedon of Barnes loam, in an area of Barnes-Svea loams, 2 to 5 percent slopes, 490 feet south and 700 feet east of the northwest corner of sec. 27, T. 152 N., R. 79 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine and few medium roots; about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw1—7 to 12 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; about 5 percent gravel; mildly alkaline; clear wavy boundary.

Bw2—12 to 18 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; mildly alkaline; gradual wavy boundary.

Bk—18 to 35 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; common fine irregularly shaped soft masses of lime; violently effervescent; mildly alkaline; gradual wavy boundary.

C—35 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, sticky and plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 5 (4 to 6 dry), and chroma of 2 to 4. It is loam or clay loam. The Bk horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (4 to 7 dry), and chroma of 2 to 4.

Buse Series

The Buse series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 3 to 25 percent.

Typical pedon of Buse loam, in an area of Barnes-Buse loams, 3 to 6 percent slopes, 200 feet north and 300 feet east of the southwest corner of sec. 25, T. 155 N., R. 80 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bk—7 to 16 inches; brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; common fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—16 to 60 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; common medium irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Cavour Series

The Cavour series consists of deep, moderately well drained, very slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Cavour loam, in an area of Cavour-Cresbard loams, 0 to 3 percent slopes, 1,425 feet east and 1,900 feet south of the northwest corner of sec. 27, T. 152 N., R. 77 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; slightly acid; clear smooth boundary.

E—7 to 10 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine platy; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; slightly acid; abrupt wavy boundary.

Bt—10 to 17 inches; very dark gray (10YR 3/1) clay loam, dark grayish brown (10YR 4/2) dry; strong medium columnar structure parting to strong medium angular blocky; extremely hard, very firm, sticky and plastic; few fine and very fine roots compressed on faces of peds; continuous distinct clay films on faces of peds and in pores; common black (10YR 2/1) organic coatings on faces of peds; gray (10YR 5/1) sand and silt grains on the top of columns; mildly alkaline; clear wavy boundary.

Btz—17 to 21 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure; very hard, firm, sticky and plastic; few fine roots; many distinct clay films on faces of peds; about 2 percent gravel; few fine irregularly shaped soft masses of lime; slightly effervescent; many irregularly shaped masses of salt crystals; moderately alkaline; gradual wavy boundary.

Bw—21 to 28 inches; olive brown (2.5Y 4/4) clay loam, light yellowish brown (2.5Y 6/4) dry; moderate medium prismatic structure; very hard, firm, sticky and plastic; about 3 percent gravel; few fine irregularly shaped soft masses of lime; slightly effervescent; strongly alkaline; gradual wavy boundary.

C—28 to 46 inches; light olive brown (2.5Y 5/4) clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/6) and common fine distinct gray (N 5/0) mottles; massive; very hard, firm, sticky and plastic; about 5 percent gravel; common fine irregularly shaped soft masses of lime; strongly effervescent; strongly alkaline; gradual wavy boundary.

Cg—46 to 60 inches; dark gray (5Y 4/1) clay loam, gray (5Y 6/1) dry; common fine distinct olive brown (2.5Y 4/4) mottles and few fine prominent yellowish red (5YR 5/8) mottles; massive; very hard, firm, sticky and plastic; about 5 percent gravel; common fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The

E horizon has value of 3 to 5 (5 to 7 dry) and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 4. It is loam or clay loam.

Claire Series

The Claire series consists of deep, excessively drained, rapidly permeable soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Claire coarse sand, in an area of Lohnes-Claire coarse sands, 0 to 6 percent slopes, 35 feet west and 30 feet south of the northeast corner of sec. 31, T. 155 N., R. 76 W.

A—0 to 9 inches; very dark gray (10YR 3/1) coarse sand, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; neutral; gradual smooth boundary.

C1—9 to 42 inches; dark brown (10YR 4/3) coarse sand, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to single grain; loose, nonsticky and nonplastic; neutral; gradual wavy boundary.

C2—42 to 60 inches; brown (10YR 5/3) coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; mildly alkaline.

The A horizon has value of 2 to 4 (4 to 6 dry) and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 3.

Colvin Series

The Colvin series consists of deep, poorly drained and very poorly drained, moderately slowly permeable, highly calcareous soils on lacustrine plains, till plains, and bottom land. These soils formed in glaciolacustrine deposits and alluvium. Slope is 0 to 1 percent.

Typical pedon of Colvin silt loam, 500 feet north and 150 feet west of the southeast corner of sec. 12, T. 153 N., R. 77 W.

Ak—0 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots and few medium roots; disseminated lime throughout; strongly effervescent; mildly alkaline; clear smooth boundary.

Bk1—10 to 23 inches; very dark gray (N 3/0) silt loam, gray (N 5/0) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and plastic; common very fine and fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—23 to 33 inches; dark gray (N 4/0) silt loam, gray (N 6/0) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and plastic; common fine and very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bk3—33 to 38 inches; dark gray (5Y 4/1) silt loam, gray (N 6/0) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine and fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg—38 to 60 inches; dark gray (5Y 4/1) silt loam, light gray (5Y 7/1) dry; common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; hard, friable, sticky and plastic; few very fine roots; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 24 inches. The Ak horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bk horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 3 to 6 (5 to 8 dry) and chroma of 0 to 2. It is silt loam or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 4 to 6 (5 to 7 dry) and chroma of 1 to 3. It is silt loam or silty clay loam. It has few to many mottles. Some pedons are saline.

Cresbard Series

The Cresbard series consists of deep, moderately well drained, slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Cresbard loam, in an area of Barnes-Cresbard loams, 0 to 3 percent slopes, 1,540 feet north and 150 feet east of the southwest corner of sec. 35, T. 152 N., R. 76 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray

(10YR 4/1) dry; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; abrupt smooth boundary.

B/E—8 to 11 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry (B) and light brownish gray (10YR 6/2) dry (E); moderate medium prismatic structure parting to moderate fine and medium subangular blocky; hard, firm, slightly sticky and slightly plastic; common very fine roots; neutral; clear wavy boundary.

Bt—11 to 18 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; strong coarse and medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds and in pores; common black (10YR 2/1) organic coatings on faces of peds; neutral; clear wavy boundary.

Bk—18 to 23 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; about 2 percent gravel; few fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

BCk—23 to 36 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; common fine prominent dark gray (5Y 4/1) mottles; massive; hard, friable, sticky and plastic; about 2 percent gravel; few fine irregularly shaped masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; olive brown (2.5Y 4/4) loam, light olive brown (2.5Y 5/4) dry; many medium distinct dark gray (5Y 4/1) and few fine prominent dark brown (7.5YR 4/4) mottles; massive; hard, firm, sticky and plastic; strongly effervescent; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 or 4 dry). Some pedons have an E horizon. The B/E horizon has value of 2 or 3 (4 to 6 dry) and chroma of 1 or 2. It is loam or clay loam. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is clay loam or loam.

Dickey Series

The Dickey series consists of deep, well drained soils on windblown till plains, moraines, and lacustrine plains. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. These soils formed in glaciofluvial deposits, glacial till, and glaciolacustrine deposits. Slope ranges from 9 to 25 percent.

Typical pedon of Dickey loamy fine sand, in an area of Dickey-Buse-Maddock complex, 9 to 25 percent slopes, 1,650 feet east and 230 feet south of the northwest corner of sec. 29, T. 154 N., R. 75 W.

A—0 to 5 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots and many medium roots; neutral; clear smooth boundary.

Bw1—5 to 14 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak very coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; clear smooth boundary.

Bw2—14 to 26 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak very coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; clear smooth boundary.

2Bk1—26 to 40 inches; light olive brown (2.5Y 5/4) loam, pale yellow (2.5Y 7/4) dry; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; about 2 percent gravel; many fine and medium irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear smooth boundary.

2Bk2—40 to 47 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate medium subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; about 2 percent gravel; common medium irregularly shaped soft masses of lime; violently effervescent; mildly alkaline; clear smooth boundary.

2C—47 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light olive brown (2.5Y 5/4) dry; weak very coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The depth to the 2Bk horizon ranges from 20 to 40

inches. The thickness of the mollic epipedon ranges from 10 to 16 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 5 dry), and chroma of 1 to 3. The 2Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. It is loam, clay loam, silt loam, or silty clay loam.

Divide Series

The Divide series consists of deep, somewhat poorly drained, highly calcareous soils on outwash plains. Permeability is moderate in the upper part of the profile and very rapid in the lower part. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Divide loam, 0 to 3 percent slopes, 1,250 feet west and 2,100 feet south of the northeast corner of sec. 8, T. 157 N., R. 80 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; mildly alkaline; abrupt smooth boundary.

Bk1—7 to 13 inches; dark gray (10YR 4/1) and gray (10YR 5/1) loam, light gray (10YR 7/1) and white (10YR 8/1) dry; weak fine prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; few fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear smooth boundary.

Bk2—13 to 21 inches; dark gray (10YR 4/1) loam, light gray (10YR 7/1) dry; weak fine prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear smooth boundary.

Bk3—21 to 23 inches; dark grayish brown (10YR 4/2) gravelly loam, light gray (10YR 7/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; about 30 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

2C—23 to 60 inches; brown (10YR 4/3) gravelly coarse sand, pale brown (10YR 6/3) dry; single grain; loose, nonsticky and nonplastic; about 30 percent gravel; slightly effervescent; moderately alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 (3 to 5 dry), and chroma of 1. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 6. It is gravelly coarse sand, coarse sand, gravelly sand, or sand.

Egeland Series

The Egeland series consists of deep, well drained, moderately rapidly permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Egeland fine sandy loam, 0 to 6 percent slopes, 1,100 feet north and 90 feet east of the southwest corner of sec. 4, T. 159 N., R. 78 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; slightly acid; abrupt smooth boundary.

Bw1—9 to 13 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; neutral; abrupt wavy boundary.

Bw2—13 to 20 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; neutral; clear wavy boundary.

BCk—20 to 35 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine irregularly shaped soft masses of lime; violently effervescent; mildly alkaline; clear wavy boundary.

C—35 to 60 inches; dark brown (10YR 4/3) stratified fine sandy loam and loam, brown (10YR 5/3) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 8 to 16 inches. The A horizon has value of 2 or 3 (3 or 4

dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 to 4.

Embden Series

The Embden series consists of deep, moderately well drained, moderately rapidly permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Embden fine sandy loam, 0 to 3 percent slopes, 2,500 feet east and 1,150 feet south of the northwest corner of sec. 23, T. 158 N., R. 78 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; neutral; abrupt smooth boundary.

Bw—8 to 22 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; neutral; clear wavy boundary.

Bk1—22 to 26 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine faint grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and nonplastic; few fine roots; few fine irregularly shaped soft masses of lime; strongly effervescent; mildly alkaline; clear wavy boundary.

Bk2—26 to 39 inches; dark grayish brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and nonplastic; few fine roots; common fine irregularly shaped soft masses of lime; strongly effervescent; mildly alkaline; gradual wavy boundary.

C—39 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; common fine distinct olive brown (2.5Y 4/4) mottles; single grain; soft, very friable, nonsticky and nonplastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 inches to more than 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 2.5Y or 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4.

Falsen Series

The Falsen series consists of deep, moderately well drained, rapidly permeable soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Falsen coarse sand, in an area of Falsen-Karlsruhe complex, 0 to 3 percent slopes, 240 feet south and 45 feet west of the northeast corner of sec. 17, T. 154 N., R. 77 W.

A—0 to 12 inches; black (10YR 2/1) coarse sand, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; neutral; clear smooth boundary.

Bw—12 to 25 inches; very dark grayish brown (10YR 3/2) coarse sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; neutral; clear smooth boundary.

BC—25 to 36 inches; very dark grayish brown (10YR 3/2) coarse sand, dark grayish brown (10YR 4/2) dry; few fine faint dark brown (10YR 4/3) mottles and common fine distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; few very fine roots; mildly alkaline; gradual smooth boundary.

C1—36 to 44 inches; grayish brown (2.5Y 5/2) coarse sand, light gray (2.5Y 7/2) dry; many medium and coarse prominent light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; few very fine roots; mildly alkaline; gradual smooth boundary.

C2—44 to 60 inches; light olive brown (2.5Y 5/4) coarse sand, light yellowish brown (2.5Y 6/4) dry; many medium and coarse prominent yellowish brown (10YR 5/8) mottles; single grain; loose, nonsticky and nonplastic; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 or 3. It is coarse sand or sand. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 2 to 4. It is coarse sand or sand.

Fargo Series

The Fargo series consists of deep, poorly drained, slowly permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Fargo silty clay, 1,400 feet east and 700 feet south of the northwest corner of sec. 1, T. 159 N., R. 79 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; very hard, firm, very sticky and very plastic; many fine and very fine roots; mildly alkaline; abrupt smooth boundary.

A—7 to 11 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to moderate fine granular; hard, firm, sticky and plastic; common fine and very fine roots; mildly alkaline; clear wavy boundary.

Bg1—11 to 18 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) dry; strong fine prismatic structure parting to strong medium angular and subangular blocky; hard, firm, very sticky and very plastic; few fine and very fine roots; waxy sheen on faces of peds when moist; tongues of A horizon extend into this horizon; mildly alkaline; gradual wavy boundary.

Bg2—18 to 32 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; strong fine prismatic structure parting to strong medium angular and subangular blocky; hard, firm, very sticky and very plastic; few very fine roots; waxy sheen on faces of peds when moist; strongly effervescent; mildly alkaline; gradual wavy boundary.

Cg1—32 to 48 inches; dark gray (5Y 4/1) clay, olive gray (5Y 5/2) dry; few fine distinct olive (5Y 5/4) mottles; massive; very hard, very firm, very sticky and very plastic; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cg2—48 to 60 inches; olive gray (5Y 4/2) silty clay, olive gray (5Y 5/2) dry; many fine distinct olive brown (2.5Y 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 8 to 24 inches. The A horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 3 or 4 dry and chroma of 0 or 1. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 3.

Fossum Series

The Fossum series consists of deep, poorly drained and very poorly drained, rapidly permeable soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Fossum fine sandy loam, in an area of Fossum and Arveson soils, 300 feet south and 1,240 feet west of the northeast corner of sec. 1, T. 155 N., R. 76 W.

A1—0 to 9 inches; black (N 2/0) fine sandy loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine and few medium roots; mildly alkaline; clear smooth boundary.

A2—9 to 13 inches; black (N 2/0) fine sandy loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; moderate fine and very fine and few medium roots; slightly effervescent; mildly alkaline; gradual wavy boundary.

AC—13 to 17 inches; very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; slightly effervescent; mildly alkaline; clear wavy boundary.

Cg1—17 to 36 inches; olive gray (5Y 5/2) fine sand, light olive gray (5Y 6/2) dry; common fine distinct light olive brown (2.5Y 5/4) mottles; single grain; loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline; gradual wavy boundary.

Cg2—36 to 60 inches; olive (5Y 4/3) fine sand, pale olive (5Y 6/3) dry; many fine distinct olive yellow (2.5Y 6/6) mottles; single grain; loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 24 inches. The A horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 or 1. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 3. It is loamy fine sand, loamy sand, fine sand, or sand.

Gardena Series

The Gardena series consists of deep, moderately well drained, moderately permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Gardena loam, 0 to 3 percent

slopes, 175 feet west and 1,040 feet south of the northeast corner of sec. 32, T. 159 N., R. 78 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

A—6 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; soft, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

Bw1—10 to 22 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; gradual wavy boundary.

Bw2—22 to 28 inches; dark brown (10YR 3/3) very fine sandy loam, brown (10YR 4/3) dry; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly effervescent; mildly alkaline; gradual wavy boundary.

BCk—28 to 34 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; disseminated lime throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

C—34 to 60 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; many fine faint light olive brown (2.5Y 5/6) mottles and common medium distinct gray (N 6/0) mottles; massive; hard, very friable, slightly sticky and slightly plastic; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 16 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. In some pedons the C horizon below a depth of 40 inches is silty clay loam or silty clay.

Glyndon Series

The Glyndon series consists of deep, somewhat poorly drained, moderately permeable, highly calcareous soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Glyndon loam, 420 feet east and 100 feet north of the southwest corner of sec. 28, T. 159 N., R. 78 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; slightly effervescent; mildly alkaline; abrupt smooth boundary.

A—8 to 12 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bk1—12 to 16 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—16 to 26 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C—26 to 60 inches; light olive brown (2.5Y 5/4) silt loam, light yellowish brown (2.5Y 6/4) dry; common medium distinct light olive brown (2.5Y 5/6) mottles and common fine distinct gray (N 6/0) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It is loam or silt loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or silt loam. Some pedons are saline.

Great Bend Series

The Great Bend series consists of deep, well drained, moderately slowly permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Great Bend silty clay loam, in an area of Great Bend-Overly complex, 0 to 3 percent slopes, 1,100 feet south and 2,540 feet west of the

northeast corner of sec. 5, T. 159 N., R. 78 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

Bw—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate coarse and very coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; neutral; clear wavy boundary.

Bk—14 to 21 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few very fine roots; disseminated lime throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

BCk—21 to 39 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, very sticky and very plastic; few very fine roots; common medium irregularly shaped soft masses of lime; violently effervescent; mildly alkaline; clear wavy boundary.

C—39 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; massive; very hard, very firm, very sticky and very plastic; few fine irregularly shaped soft masses of lime; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or silt loam. The C horizon has value of 4 to 6 (6 to 8 dry) and chroma of 2 to 4. It is silty clay loam or silty clay.

Hamerly Series

The Hamerly series consists of deep, somewhat poorly drained, moderately slowly permeable, highly calcareous soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 3 percent.

Typical pedon of Hamerly loam, 0 to 3 percent slopes, 120 feet east and 425 feet south of the northwest corner of sec. 34, T. 154 N., R. 80 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; about 5 percent gravel; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Bk1—6 to 19 inches; light brownish gray (2.5Y 6/2) loam, white (2.5Y 8/2) dry; few fine distinct light yellowish brown (2.5Y 6/4) mottles; moderate coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—19 to 32 inches; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; common fine distinct yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) mottles; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C1—32 to 39 inches; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; about 5 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—39 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; many medium distinct gray (5Y 5/1) mottles and common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; hard, friable, sticky and plastic; about 5 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (5 to 8 dry), and chroma of 1 to 4. It is loam or clay loam. Some pedons are saline.

Harriet Series

The Harriet series consists of deep, poorly drained, very slowly permeable, alkali soils on bottom land. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Harriet silt loam, 870 feet north and 300 feet west of the southeast corner of sec. 2, T. 159 N., R. 76 W.

E—0 to 1 inch; black (10YR 2/1) silt loam, gray (10YR

5/1) dry; weak very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; neutral; abrupt smooth boundary.

Bt—1 to 9 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong medium columnar structure parting to strong fine and very fine angular blocky; very hard, very firm, very sticky and very plastic; many fine and medium roots; many distinct clay films on faces of peds; gray (10YR 5/1) sand and silt coatings on the top of peds; mildly alkaline; clear wavy boundary.

Btz—9 to 17 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong medium prismatic structure parting to strong fine and very fine angular blocky; very hard, very firm, very sticky and very plastic; few fine roots; many distinct clay films on faces of peds; few fine and medium threads of salt crystals; moderately alkaline; gradual wavy boundary.

Btk—17 to 23 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; moderate medium prismatic structure parting to moderate fine angular blocky; hard, firm, sticky and plastic; few fine roots; common distinct clay films on faces of peds; common medium irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

BCk1—23 to 35 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; many fine irregularly shaped soft masses of lime; violently effervescent; strongly alkaline; gradual wavy boundary.

BCk2—35 to 42 inches; grayish brown (2.5Y 5/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of lime; violently effervescent; strongly alkaline; gradual wavy boundary.

C—42 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; few medium distinct light olive brown (2.5Y 5/4) mottles; massive; soft, very friable, nonsticky and nonplastic; strongly effervescent; strongly alkaline.

The E horizon has hue of 10YR or 2.5Y and value of 2 to 4 (4 to 6 dry). The Bt horizon has hue of 10YR to 5Y, value of 2 to 4 (4 or 5 dry), and chroma of 1 or 2. It is clay loam, silty clay loam, or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 3.

Hecla Series

The Hecla series consists of deep, moderately well drained, rapidly permeable soils on delta plains and outwash plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Hecla loamy fine sand, 0 to 3 percent slopes, 2,500 feet west and 330 feet north of the southeast corner of sec. 8, T. 159 N., R. 77 W.

A1—0 to 5 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; neutral; clear smooth boundary.

A2—5 to 15 inches; very dark gray (10YR 3/1) fine sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; mildly alkaline; clear wavy boundary.

AC—15 to 30 inches; very dark grayish brown (10YR 3/2) fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; mildly alkaline; gradual wavy boundary.

C1—30 to 36 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; single grain; loose, nonsticky and nonplastic; few fine roots; mildly alkaline; gradual wavy boundary.

C2—36 to 52 inches; grayish brown (2.5Y 5/2) fine sand, light gray (2.5Y 7/2) dry; common fine distinct yellowish brown (10YR 5/4) mottles; single grain; loose, nonsticky and nonplastic; strongly effervescent; moderately alkaline; clear wavy boundary.

C3—52 to 60 inches; light olive brown (2.5Y 5/4) fine sand, pale yellow (2.5Y 7/4) dry; few fine distinct grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) mottles; single grain; loose, nonsticky and nonplastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The depth to mottles ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry). The C horizon has hue of 10YR, 5Y, or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand, or fine sand.

Karlsruhe Series

The Karlsruhe series consists of deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Karlsruhe coarse sandy loam, 250 feet east and 2,400 feet south of the northwest corner of sec. 16, T. 154 N., R. 76 W.

A—0 to 5 inches; black (10YR 2/1) coarse sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; disseminated lime throughout; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Ak—5 to 11 inches; very dark gray (10YR 3/1) coarse sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; disseminated lime throughout; strongly effervescent; mildly alkaline; clear smooth boundary.

ABk—11 to 15 inches; very dark gray (10YR 3/1) loamy coarse sand, gray (10YR 5/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; clear smooth boundary.

Bk—15 to 20 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, gray (10YR 5/1) dry; common fine faint dark brown (10YR 3/3) mottles; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

BCk—20 to 30 inches; dark brown (10YR 3/3) coarse sand, brown (10YR 5/3) dry; many medium faint dark grayish brown (10YR 4/2) mottles; single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; lime disseminated throughout; strongly effervescent; mildly alkaline; gradual wavy boundary.

C1—30 to 39 inches; very dark grayish brown (10YR 3/2) coarse sand, grayish brown (2.5Y 5/2) dry; many medium faint dark brown (10YR 3/3) mottles; single grain; soft, very friable, nonsticky and nonplastic; few very fine roots; slightly effervescent; mildly alkaline; gradual wavy boundary.

C2—39 to 60 inches; dark grayish brown (2.5Y 4/2) coarse sand, olive brown (2.5Y 4/4) dry; many medium distinct light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). It is sandy loam or coarse sandy loam. The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 to 4. It is coarse sandy loam, loamy coarse sand, sandy loam, or loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 8. It is coarse sand or sand.

LaDelle Series

The LaDelle series consists of deep, moderately well drained, moderately slowly permeable soils on terraces and bottom land. These soils formed in alluvium. Slope ranges from 0 to 3 percent.

Typical pedon of LaDelle silty clay loam, 0 to 3 percent slopes, 1,580 feet east and 1,205 feet south of the northwest corner of sec. 24, T. 153 N., R. 80 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; neutral; abrupt smooth boundary.

A—6 to 20 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine and few fine roots; neutral; gradual wavy boundary.

Bw—20 to 35 inches; very dark grayish brown (10YR 3/2) and very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) and dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; hard, firm, sticky and plastic; few very fine roots; few fine irregularly shaped soft threads and masses of lime; very slightly effervescent; mildly alkaline; clear smooth boundary.

Bk—35 to 44 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common fine irregularly shaped soft masses and threads of lime; strongly effervescent; moderately alkaline; clear smooth boundary.

C—44 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard, friable, sticky and plastic; few fine irregularly shaped soft masses of lime; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 20 to 40 inches. The A horizon has hue of 10YR, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1 or 2. Some pedons do not have a Bw horizon. The C horizon has hue of 10YR or 2.5Y, value of 2 to 5 (3 to 7 dry), and chroma of 1 to 3. It is loam, silty clay loam, or silt loam. Some pedons have an Ab horizon.

Larson Series

The Larson series consists of deep, moderately well drained, slowly permeable, alkali soils on windblown till plains. These soils formed in windblown glaciofluvial deposits and glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Larson fine sandy loam, in an area of Swenoda-Larson fine sandy loams, 0 to 3 percent slopes, 1,930 feet west and 250 feet north of the southeast corner of sec. 25, T. 151 N., R. 76 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

A—6 to 12 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; about 2 percent gravel; neutral; clear wavy boundary.

E—12 to 14 inches; very dark grayish brown (10YR 3/2) loamy fine sand, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; about 2 percent gravel; mildly alkaline; clear wavy boundary.

Bt—14 to 27 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; strong coarse columnar structure; very hard, firm, sticky and plastic; few very fine roots; many distinct clay films on faces of peds; common very dark gray (10YR 3/1) organic coatings on faces of peds; about 3 percent gravel; moderately alkaline; clear irregular boundary.

Bky—27 to 36 inches; yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; common fine distinct grayish brown (2.5Y 5/2) mottles and few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; about 8 percent gravel; few fine irregularly shaped soft masses of lime; violently effervescent; few fine masses of gypsum crystals; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; common medium prominent olive gray (5Y 5/2) mottles and common medium distinct olive (5Y 4/4) mottles; massive; hard, friable, slightly sticky and slightly plastic; about 8 percent gravel; strongly effervescent; moderately alkaline.

The Ap horizon has value of 2 or 3 (3 to 5 dry). The E horizon has hue of 10YR or 2.5Y, value of 2 to 5 (5 to 7 dry), and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is loam or clay loam. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Letcher Series

The Letcher series consists of deep, moderately well drained, alkali soils on outwash plains. Permeability is slow in the upper part of the profile and moderately rapid in the lower part. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Letcher fine sandy loam, 0 to 3 percent slopes, 1,420 feet south and 200 feet west of the northeast corner of sec. 33, T. 153 N., R. 77 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; slightly acid; abrupt smooth boundary.

E—8 to 12 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; mildly alkaline; clear smooth boundary.

Bt—12 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; strong coarse columnar structure parting to strong coarse angular blocky; very hard, very firm,

sticky and plastic; few very fine roots compressed on faces of peds; common faint clay films on faces of peds; light gray (10YR 7/2) silt coatings on the top of columns; strongly alkaline; clear smooth boundary.

Btkz—17 to 25 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; strong coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky and slightly plastic; few very fine roots; few faint clay films on faces of peds; common medium irregularly shaped soft masses of lime; strongly effervescent; few irregularly shaped masses of salt crystals; strongly alkaline; abrupt smooth boundary.

Ab—25 to 33 inches; very dark brown (10YR 2/2) fine sandy loam, very dark grayish brown (10YR 3/2) dry; moderate very coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine irregularly shaped soft masses of lime; slightly effervescent; strongly alkaline; abrupt smooth boundary.

BCkz—33 to 44 inches; light olive brown (2.5Y 5/4) loam, light gray (2.5Y 7/2) dry; massive; extremely hard, firm, sticky and plastic; disseminated lime throughout; violently effervescent; common fine irregularly shaped masses of salt crystals; strongly alkaline; abrupt smooth boundary.

C—44 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct yellow (2.5Y 7/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; slightly effervescent; strongly alkaline.

The A horizon has value of 2 or 3 (4 or 5 dry). The E horizon has value of 3 to 5 (5 to 7 dry) and chroma of 1 or 2. It is fine sandy loam, sandy loam, or loamy fine sand. The Bt horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is fine sandy loam or sandy loam. The BCkz horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. It is loam, fine sandy loam, or sandy loam. The C horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 7 dry), and chroma of 1 to 4. It is fine sandy loam, sandy loam, or loamy fine sand. Some pedons do not have an Ab horizon.

Lohnes Series

The Lohnes series consists of deep, well drained, rapidly permeable soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 15 percent.

Typical pedon of Lohnes coarse sand, in an area of Lohnes-Claire coarse sands, 0 to 6 percent slopes, 2,450 feet south and 1,100 feet west of the northeast corner of sec. 2, T. 156 N., R. 76 W.

Ap—0 to 5 inches; black (10YR 2/1) coarse sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; neutral; abrupt smooth boundary.

A—5 to 11 inches; black (10YR 2/1) coarse sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to single grain; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; neutral; clear wavy boundary.

Bw1—11 to 17 inches; very dark grayish brown (10YR 3/2) coarse sand, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure parting to single grain; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; neutral; abrupt wavy boundary.

Bw2—17 to 28 inches; dark brown (10YR 3/3) coarse sand, dark yellowish brown (10YR 4/4) dry; weak medium subangular blocky structure parting to single grain; loose, nonsticky and nonplastic; about 5 percent gravel; mildly alkaline; clear wavy boundary.

C1—28 to 49 inches; dark brown (10YR 4/3) coarse sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; about 2 percent gravel; very slightly effervescent; mildly alkaline; gradual wavy boundary.

C2—49 to 60 inches; dark yellowish brown (10YR 4/4) coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; about 2 percent gravel; very slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has value of 3 or 4 (4 or 5 dry) and chroma of 2 to 4. It is sand or coarse sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. It is coarse sand or sand.

Ludden Series

The Ludden series consists of deep, poorly drained and very poorly drained, slowly permeable soils on bottom land. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Ludden clay, 200 feet east and 280 feet north of the southwest corner of sec. 32, T. 159 N., R. 76 W.

Oi—2 inches to 0; very dark gray (10YR 3/1) mostly undecomposed stems and roots; medium acid; abrupt smooth boundary.

A—0 to 5 inches; black (N 2/0) clay, very dark gray (N 3/0) dry; moderate very fine subangular blocky structure; very hard, very firm, very sticky and very plastic; many very fine and few fine roots; slightly acid; clear smooth boundary.

Bzg1—5 to 12 inches; black (5Y 2/1) silty clay, gray (5Y 5/1) dry; few fine prominent dark yellowish brown (10YR 4/4) mottles; moderate coarse prismatic structure parting to strong very fine subangular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; tongues of A horizon material extend into this horizon; very slightly effervescent; common fine threads of salt crystals; moderately alkaline; clear smooth boundary.

Bzg2—12 to 17 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; common fine prominent dark yellowish brown (10YR 4/4) mottles; moderate coarse prismatic structure parting to moderate very fine subangular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; tongues of A horizon material extend into this horizon; slightly effervescent; common fine threads of salt crystals; moderately alkaline; clear smooth boundary.

Aygb—17 to 30 inches; black (5Y 2/1) clay, very dark gray (N 3/0) dry; moderate very fine subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; few medium irregularly shaped soft masses of lime; slightly effervescent; many fine and medium masses of gypsum crystals; moderately alkaline; clear smooth boundary.

Bygb—30 to 43 inches; very dark gray (5Y 3/1) clay, dark gray (5Y 4/1) dry; weak very fine subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; few large irregularly shaped soft masses of lime; slightly effervescent; common medium and large masses of gypsum; moderately alkaline; clear smooth boundary.

Cg—43 to 60 inches; dark olive gray (5Y 3/2) clay, olive gray (5Y 5/2) dry; massive; very hard, very firm, very sticky and very plastic; few large irregularly shaped soft masses of lime; slightly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 24 to 48 inches. The A horizon has hue of 10YR, 2.5Y, or 5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The B horizon has hue of 2.5Y or 5Y, value of 2 or 3 (4 to 6 dry), and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 3 or 4 (3 to 5 dry), and chroma of 1 or 2. It is silty clay or clay. Some pedons are nonsaline.

Maddock Series

The Maddock series consists of deep, well drained, rapidly permeable soils on outwash plains and delta plains and on windblown till plains and moraines. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 25 percent.

Typical pedon of Maddock loamy fine sand, in an area of Maddock-Hecla loamy fine sands, 1 to 6 percent slopes, 180 feet north and 500 feet east of the southwest corner of sec. 9, T. 158 N., R. 75 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; neutral; abrupt smooth boundary.

A—6 to 10 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and medium roots; neutral; clear wavy boundary.

Bw—10 to 15 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; neutral; gradual wavy boundary.

C1—15 to 43 inches; dark grayish brown (10YR 4/2) loamy fine sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; neutral; gradual wavy boundary.

C2—43 to 60 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; strongly effervescent; neutral.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has value of 2 to 5 (4 to 6 dry) and chroma of 2 to 4. It is loamy fine sand, loamy sand, fine sand, or sand. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 7 dry), and chroma of 2 to 4. It is loamy fine sand, loamy sand, fine sand, or sand.

Marysland Series

The Marysland series consists of deep, poorly drained, highly calcareous soils on outwash plains. Permeability is moderate in the upper part of the profile and rapid in the lower part. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Marysland silt loam, 160 feet south and 1,990 feet west of the northeast corner of sec. 33, T. 157 N., R. 80 W.

Oi—2 inches to 0; very dark gray (10YR 3/1) mostly undecomposed stems, leaves, and roots; mildly alkaline; abrupt smooth boundary.

Ak—0 to 9 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; moderate fine and very fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; disseminated lime throughout; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bk—9 to 17 inches; very dark gray (N 3/0) silt loam, gray (N 6/0) dry; moderate medium and coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; abrupt smooth boundary.

Ab—17 to 35 inches; very dark gray (10YR 3/1) sandy clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2Cg—35 to 60 inches; olive gray (5Y 5/2) coarse sand, light olive gray (5Y 6/2) dry; single grain; loose, nonsticky and nonplastic; slightly effervescent; moderately alkaline.

The depth to the 2C horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (2 to 5 dry). The Bk horizon has hue of 10YR, 2.5Y, or 5Y, or it is neutral in hue. It has value of 2 to 4 (3 to 6 dry) and chroma of 0 to 2. The 2Cg horizon has hue of 2.5Y or 5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1 or 2. It is sand, coarse sand, or gravelly coarse sand. Some pedons do not have an Ab horizon.

Max Series

The Max series consists of deep, well drained, moderately slowly permeable soils on dissected till plains. These soils formed in glacial till. Slopes range from 6 to 45 percent.

Typical pedon of Max loam, in an area of Zahl-Max-Svea loams, 6 to 60 percent slopes, 2,350 feet north and 1,440 feet east of the southwest corner of sec. 29, T. 153 N., R. 80 W.

A—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; about 2 percent gravel; neutral; clear wavy boundary.

Bw1—6 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, sticky and plastic; many very fine and common fine roots; about 2 percent gravel; mildly alkaline; gradual wavy boundary.

Bw2—11 to 16 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium and coarse prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots; about 2 percent gravel; mildly alkaline; clear smooth boundary.

Bk1—16 to 26 inches; olive brown (2.5Y 4/4) loam, light yellowish brown (2.5Y 6/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; disseminated lime throughout; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bk2—26 to 37 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; weak coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; gradual smooth boundary.

C—37 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; massive; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; few fine irregularly shaped soft masses of lime; slightly effervescent; moderately alkaline.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 2 or 3. The Bw horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 to 4. The Bk horizon has

value of 4 to 6 (5 to 7 dry) and chroma of 2 to 4. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 to 4.

Minnewaukan Series

The Minnewaukan series consists of deep, poorly drained, rapidly permeable soils on windblown delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Minnewaukan loamy fine sand, in an area of Aylmer-Minnewaukan complex, 0 to 6 percent slopes, 800 feet south and 880 feet east of the northwest corner of sec. 10, T. 157 N., R. 76 W.

A—0 to 3 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and very fine and few medium roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Cg1—3 to 10 inches; olive (5Y 5/3) fine sand, pale olive (5Y 6/3) dry; common fine prominent yellowish brown (10YR 5/4) mottles and common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure parting to single grain; loose, nonsticky and nonplastic; many fine and very fine and few medium roots; strongly effervescent; mildly alkaline; clear wavy boundary.

Cg2—10 to 43 inches; gray (5Y 5/1) fine sand, gray (5Y 6/1) dry; many medium prominent light olive brown (2.5Y 5/4) mottles; single grain; loose, nonsticky and nonplastic; common fine and very fine and few medium roots; slightly effervescent; mildly alkaline; clear wavy boundary.

C3—43 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; many medium distinct dark grayish brown (2.5Y 4/2) mottles; single grain; loose, nonsticky and nonplastic; few fine and very fine roots; slightly effervescent; mildly alkaline.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (4 to 7 dry), and chroma of 1 to 4. Some pedons are loam, silt, or clay loam below a depth of 40 inches.

Miranda Series

The Miranda series consists of deep, somewhat poorly drained, very slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope is 0 to 1 percent.

Typical pedon of Miranda loam, in an area of Miranda-Cavour loams, 100 feet north and 960 feet west of the southeast corner of sec. 36, T. 152 N., R. 78 W.

E—0 to 3 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; slightly acid; abrupt smooth boundary.

Bt—3 to 8 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong coarse columnar structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; common fine and very fine roots; many distinct clay films on faces of blocky peds; dark grayish brown (10YR 4/2) silt coatings on the top of columnar peds; moderately alkaline; abrupt wavy boundary.

Btyz—8 to 13 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; strong coarse prismatic structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; common fine and very fine roots; common distinct clay films on faces of peds; few fine threads of salt crystals; common fine irregularly shaped masses of gypsum crystals; strongly effervescent; moderately alkaline; clear wavy boundary.

Bkz—13 to 43 inches; olive brown (2.5Y 4/4) clay loam, light olive brown (2.5Y 5/4) dry; few fine distinct yellowish brown (10YR 5/6) mottles and few medium distinct gray (10YR 5/1) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; about 5 percent gravel; many fine threads of salt; few fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk—43 to 56 inches; dark grayish brown (2.5Y 4/2) sandy clay loam, olive brown (2.5Y 4/4) dry; common medium faint grayish brown (2.5Y 5/2) mottles and common fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; common fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C—56 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; common

medium distinct dark gray (N 4/0) mottles and common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; about 5 percent gravel; few fine irregularly shaped soft masses of lime; slightly effervescent; moderately alkaline.

The E horizon has value of 4 to 6 dry and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 2 or 3 (4 to 5 dry), and chroma of 1 or 2. The C horizon has value of 4 or 5 (5 to 7 dry) and chroma of 2 or 4. It is loam or clay loam.

Niobell Series

The Niobell series consists of deep, moderately well drained, slowly permeable, alkali soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Niobell loam, in an area of Williams-Niobell loams, 0 to 3 percent slopes, 2,275 feet east and 1,385 feet north of the southwest corner of sec. 35, T. 151 N., R. 79 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; medium acid; abrupt smooth boundary.

B/E—7 to 14 inches; dark brown (10YR 3/3) and dark grayish brown (10YR 4/2) loam, brown (10YR 5/3) dry (B) and light brownish gray (10YR 6/2) dry (E); moderate coarse prismatic structure parting to moderate medium angular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; slightly acid; clear smooth boundary.

Bt1—14 to 19 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry; strong medium prismatic structure parting to strong medium and fine angular blocky; very hard, firm, sticky and plastic; few very fine roots; many faint clay films on faces of peds and in pores; few very dark brown (10YR 2/2) organic coatings on faces of peds; neutral; clear smooth boundary.

Bt2—19 to 25 inches; olive brown (2.5Y 4/4) clay loam, light olive brown (2.5Y 5/4) dry; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, sticky and plastic; few very fine roots; many faint clay films on faces of peds and in pores; about 2 percent gravel; mildly alkaline; clear smooth boundary.

Btk—25 to 31 inches; olive brown (2.5Y 4/4) clay loam, light brownish gray (2.5Y 6/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few very fine roots; few faint clay films on faces of peds; about 5 percent gravel; common medium and fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; clear smooth boundary.

Cg—31 to 60 inches; olive (5Y 4/3) loam, pale olive (5Y 6/3) dry; few fine distinct dark gray (5Y 4/1) mottles and few fine prominent yellow (2.5Y 7/6) mottles; weak fine and medium subangular blocky structure; hard, firm, sticky and plastic; about 5 percent gravel; many medium irregularly shaped soft masses of lime; strongly effervescent; few fine masses of gypsum crystals; moderately alkaline.

The A horizon has value of 2 or 3 (4 or 5 dry). Some pedons have an E horizon. The Bt horizon has hue of 10YR or 2.5Y, value of 2 to 4 (4 to 6 dry), and chroma of 2 to 4. The Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Overly Series

The Overly series consists of deep, moderately well drained, moderately slowly permeable soils on lacustrine plains. These soils formed in glaciolacustrine deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Overly loam, in an area of Great Bend-Overly complex, 0 to 3 percent slopes, 225 feet north and 530 feet west of the southeast corner of sec. 4, T. 159 N., R. 78 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; neutral; abrupt smooth boundary.

A—6 to 11 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, friable, sticky and plastic; common fine and very fine roots; neutral; clear wavy boundary.

Bw—11 to 25 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; common fine and very fine roots; mildly alkaline; clear smooth boundary.

BCk—25 to 31 inches; brown (10YR 5/3) silt loam, very

pale brown (10YR 7/3) dry; massive; hard, firm, sticky and plastic; common fine and very fine roots; common fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear wavy boundary.

C1—31 to 38 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—38 to 60 inches; light olive brown (2.5Y 5/4) silt loam, pale yellow (2.5Y 7/4) dry; common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; hard, firm, sticky and plastic; few fine roots; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 3. It is silt loam or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 or 7 dry), and chroma of 1 to 4. It is silt loam or silty clay loam.

Parnell Series

The Parnell series consists of deep, very poorly drained, slowly permeable soils on till plains and lacustrine plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Parnell silty clay loam, 900 feet west and 1,750 feet north of the southeast corner of sec. 11, T. 154 N., R. 80 W.

Oi—1 inch to 0; black (10YR 2/1) mostly undecomposed stems, leaves, and roots; slightly acid; abrupt smooth boundary.

A1—0 to 6 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium platy structure; slightly hard, friable, sticky and plastic; few coarse and many medium and fine roots; neutral; clear wavy boundary.

A2—6 to 13 inches; black (5Y 2/1) silty clay loam, dark gray (5Y 4/1) dry; moderate medium and fine granular structure; slightly hard, friable, sticky and plastic; many medium and fine and few very fine roots; neutral; clear wavy boundary.

Btg—13 to 44 inches; black (5Y 2/1) silty clay, dark gray (5Y 4/1) dry; weak coarse prismatic structure parting to moderate coarse subangular blocky; very hard, very firm, very sticky and very plastic; few medium, common fine, and few very fine roots; many distinct clay films on faces of peds; neutral; clear wavy boundary.

C—44 to 60 inches; grayish brown (2.5Y 5/2) silty clay, light gray (5Y 7/2) dry; many coarse prominent yellowish brown (10YR 5/6) mottles; massive; very hard, firm, very sticky and very plastic; common fine irregularly shaped soft masses of lime; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 24 to 60 inches. Some pedons do not have an O horizon.

The A horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 or 1. The Bt horizon has hue of 10YR to 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is silty clay or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2.

Rifle Series

The Rifle series consists of deep, very poorly drained, moderately rapidly permeable, organic soils on elevated bottom land. These soils formed in organic deposits. Slope is 0 to 1 percent.

Typical pedon of Rifle mucky peat, 2,150 feet east and 1,600 feet south of the northwest corner of sec. 25, T. 155 N., R. 77 W.

Oe1—0 to 6 inches; black (10YR 2/1) and very dark brown (10YR 2/2, rubbed) mucky peat; about 55 percent fiber, 25 percent rubbed; massive; nonsticky and nonplastic; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Oe2—6 to 23 inches; very dark brown (10YR 2/2) and dark brown (7.5YR 3/2, rubbed) mucky peat; about 35 percent fiber, 20 percent rubbed; massive; nonsticky and nonplastic; common shell fragments; slightly effervescent; mildly alkaline; gradual smooth boundary.

Oe3—23 to 60 inches; black (10YR 2/1) and very dark brown (10YR 2/2, rubbed) mucky peat; about 50 percent fiber, 30 percent rubbed; massive; nonsticky and nonplastic; few shell fragments; slightly effervescent; mildly alkaline.

The Oe1 horizon has value of 2 or 3 and chroma of 1 to 3. It is about 40 to 55 percent fiber, unrubbed, and 25 to 35 percent fiber, rubbed. The Oe2 horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 to 3. It is about 35 to 60 percent fiber, unrubbed, and 20 to 30 percent fiber, rubbed. The Oe3 horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1

or 2. It is about 45 to 60 percent fiber, unrubbed, and 30 to 45 percent fiber, rubbed. Some pedons have a mineral C horizon below a depth of 51 inches.

Ryan Series

The Ryan series consists of deep, poorly drained, very slowly permeable, alkali soils on bottom land. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Ryan loam, 250 feet north and 890 feet east of the southwest corner of sec. 31, T. 156 N., R. 76 W.

E—0 to 1 inch; black (10YR 2/1) loam, gray (10YR 5/1) dry; weak very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; neutral; abrupt wavy boundary.

Bt—1 to 10 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong medium columnar structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; common very fine and fine roots confined to faces of peds; continuous distinct clay films on faces of peds; gray (10YR 6/1) silt grains coating the top of columnar peds; moderately alkaline; clear wavy boundary.

Btz—10 to 14 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong medium prismatic structure parting to strong fine and very fine angular blocky; extremely hard, very firm, very sticky and very plastic; common fine and very fine roots; continuous distinct clay films on faces of peds; few fine irregularly shaped masses of salt crystals; few fine irregularly shaped soft masses of lime; slightly effervescent; moderately alkaline; clear wavy boundary.

Bkzg1—14 to 23 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; common thin clay films lining pores; common fine irregularly shaped masses of salt crystals; few fine irregularly shaped soft masses of lime; strongly effervescent; strongly alkaline; clear wavy boundary.

Bkzg2—23 to 35 inches; dark gray (5Y 4/1) silty clay, gray (5Y 6/1) dry; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm, sticky and plastic; few very fine roots; common thin clay films lining pores; few fine irregularly shaped masses of salt crystals; few fine irregularly shaped soft masses of lime; strongly effervescent; strongly alkaline; clear wavy boundary.

Cg—35 to 60 inches; olive gray (5Y 4/2) silty clay loam, light olive gray (5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; few fine irregularly shaped masses of salt crystals; few fine irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The E horizon has hue of 10YR to 5Y and value of 2 or 3 (3 to 5 dry). The Bt horizon has hue of 10YR to 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is silty clay or clay. The Cg horizon has hue of 2.5Y or 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 to 3. It is silty clay, clay, or silty clay loam.

Serden Series

The Serden series consists of deep, excessively drained, rapidly permeable soils on windblown delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 3 to 50 percent.

Typical pedon of Serden sand, 3 to 50 percent slopes, 50 feet south and 600 feet west of the northeast corner of sec. 35, T. 159 N., R. 77 W.

A—0 to 2 inches; very dark gray (10YR 3/1) sand, dark gray (10YR 4/1) dry; weak fine granular structure; loose, nonsticky and nonplastic; common fine and very fine roots; neutral; clear smooth boundary.

C1—2 to 8 inches; dark grayish brown (10YR 4/2) sand, brown (10YR 5/3) dry; single grain; loose, nonsticky and nonplastic; few fine and very fine roots; neutral; clear wavy boundary.

C2—8 to 60 inches; brown (10YR 4/3) sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; neutral.

The A horizon has value of 2 to 4 (3 to 6 dry) and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 3 to 6 (5 to 7 dry), and chroma of 2 to 4. It is sand or fine sand.

Sioux Series

The Sioux series consists of deep, excessively drained, very rapidly permeable soils on outwash plains and terraces. These soils formed in glaciofluvial deposits. Slope ranges from 1 to 25 percent.

Typical pedon of Sioux gravelly sandy loam, 1 to 6 percent slopes, 2,595 feet west and 750 feet south of the northeast corner of sec. 34, T. 157 N., R. 80 W.

A—0 to 5 inches; very dark gray (10YR 3/1) gravelly

sandy loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; about 15 percent gravel; neutral; clear smooth boundary.

AC—5 to 7 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; about 20 percent gravel; mildly alkaline; gradual wavy boundary.

C—7 to 60 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand, light gray (10YR 7/2) dry; single grain; loose, nonsticky and nonplastic; about 45 percent gravel; strongly effervescent; mildly alkaline.

The thickness of the mollic epipedon and the depth to very gravelly coarse sand range from 7 to 14 inches. The A horizon has value of 2 or 3 (3 to 5 dry). It has a gravel content of 15 to 25 percent. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It has a gravel content of 35 to 60 percent.

Southam Series

The Southam series consists of deep, very poorly drained, slowly permeable soils on till plains and lacustrine plains. These soils formed in alluvium. Slope is 0 to 1 percent.

Typical pedon of Southam silt loam, 2,200 feet north and 800 feet east of the southwest corner of sec. 22, T. 152 N., R. 75 W.

Ag1—0 to 3 inches; black (5Y 2/1) silt loam, gray (5Y 5/1) dry; weak fine angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; about 1 percent fine shell fragments; strongly effervescent; mildly alkaline; gradual smooth boundary.

Ag2—3 to 11 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; about 3 percent fine shell fragments; strongly effervescent; mildly alkaline; gradual wavy boundary.

Ag3—11 to 36 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; massive; hard, firm, sticky and plastic; about 10 percent shell fragments; strongly effervescent; mildly alkaline; gradual wavy boundary.

Cg1—36 to 43 inches; dark gray (5Y 4/1) silty clay loam, light gray (5Y 7/1) dry; massive; very hard, firm, sticky and plastic; about 1 percent shell fragments; strongly effervescent; mildly alkaline; clear wavy boundary.

Cg2—43 to 60 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; massive; very hard, firm, sticky and plastic; about 1 percent shell fragments; strongly effervescent; mildly alkaline.

The A horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. The Cg horizon has hue of 2.5Y or 5Y, or it is neutral in hue. It has value of 3 to 7 (4 to 8 dry) and chroma of 0 to 2. It is silty clay loam, silty clay, clay loam, or clay.

Stirum Series

The Stirum series consists of deep, poorly drained, alkali soils on outwash plains and delta plains. Permeability is moderately slow in the upper part of the profile and moderately rapid in the lower part. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Stirum fine sandy loam, 860 feet south and 2,600 feet west of the northeast corner of sec. 17, T. 158 N., R. 77 W.

A—0 to 5 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; many fine and very fine roots; mildly alkaline; abrupt smooth boundary.

Btk—5 to 10 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; strong coarse columnar structure parting to strong medium and coarse angular blocky; very hard, firm, slightly sticky and slightly plastic; common fine and very fine roots compressed on faces of peds; common distinct clay bridges between mineral grains; continuous black (10YR 2/1) organic stains on faces of peds; uncoated sand grains on faces of peds; few very fine masses of salt crystals; disseminated lime throughout interior of peds; strongly effervescent; moderately alkaline; clear irregular boundary.

Btkg—10 to 26 inches; gray (5Y 5/1) and light gray (5Y 7/1) fine sandy loam, light gray (5Y 6/1) and white (N 8/0) dry; strong coarse prismatic structure parting to strong medium and fine angular blocky; hard, firm, slightly sticky and plastic; few fine and very fine roots; common distinct clay bridges

between sand grains; common very dark gray (10YR 3/1) organic stains on faces of peds; uncoated sand grains on faces of peds; disseminated lime throughout; violently effervescent; very strongly alkaline; clear smooth boundary.

Bk—26 to 38 inches; light olive brown (2.5Y 5/4) stratified fine sandy loam and very fine sandy loam, pale yellow (2.5Y 7/4) dry; common fine distinct yellowish brown (10YR 5/6) and gray (5Y 6/1) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and very fine roots; disseminated lime throughout; violently effervescent; very strongly alkaline; gradual wavy boundary.

BCk—38 to 46 inches; light olive brown (2.5Y 5/4) loamy fine sand, pale yellow (2.5Y 7/4) dry; common fine distinct dark yellowish brown (10YR 4/4) and grayish brown (2.5Y 5/2) mottles; massive; soft, very friable, nonsticky and nonplastic; disseminated lime throughout; violently effervescent; strongly alkaline; gradual wavy boundary.

C—46 to 60 inches; olive brown (2.5Y 4/4) fine sandy loam, pale yellow (2.5Y 7/4) dry; common fine distinct yellowish brown (10YR 5/6) mottles and common medium distinct grayish brown (2.5Y 5/2) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium irregularly shaped soft masses of lime; strongly effervescent; strongly alkaline.

The A horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 to 2. Some pedons have an E horizon. The Btk horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 3 to 6 (4 to 8 dry) and chroma of 0 to 2. It is fine sandy loam or loam. The Bk horizon has hue of 10YR to 5Y, value of 4 to 7 (5 to 8 dry), and chroma of 1 to 4. It is fine sandy loam, very fine sandy loam, or loam. The C horizon is loamy fine sand, fine sandy loam, or loam.

Svea Series

The Svea series consists of deep, well drained and moderately well drained, moderately slowly permeable soils on till plains. These soils formed in glacial till. Slope ranges from 0 to 15 percent.

Typical pedon of Svea loam, in an area of Svea-Barnes loams, 0 to 2 percent slopes, 450 feet south and 2,200 feet east of the northwest corner of sec. 14, T. 154 N., R. 80 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; about 5 percent gravel; slightly acid; clear smooth boundary.

Bw1—9 to 22 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; about 5 percent gravel; neutral; gradual wavy boundary.

Bw2—22 to 32 inches; dark grayish brown (10YR 4/2) clay loam, brown (10YR 5/3) dry; few fine faint dark brown (10YR 4/3) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; about 10 percent gravel; neutral; clear smooth boundary.

BCk—32 to 45 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine prominent strong brown (7.5YR 5/6) mottles and common fine distinct dark gray (5Y 4/1) mottles; massive; hard, firm, sticky and plastic; about 10 percent gravel; common fine irregularly shaped soft masses of lime; violently effervescence; mildly alkaline; gradual wavy boundary.

C—45 to 60 inches; light olive brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct strong brown (7.5YR 5/6) and dark gray (5Y 4/1) mottles; massive; hard, firm, sticky and plastic; about 10 percent gravel; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 16 to 30 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 to 4. It is loam or clay loam. The C horizon has hue of 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4.

Swenoda Series

The Swenoda series consists of deep, moderately well drained soils on windblown lacustrine plains and till plains. Permeability is moderately rapid in the upper part of the profile and moderately slow in the lower part. These soils formed in glaciofluvial deposits, glaciolacustrine deposits, and glacial till. Slope ranges from 0 to 6 percent.

Typical pedon of Swenoda fine sandy loam, 0 to 3 percent slopes, 100 feet north and 825 feet west of the

southeast corner of sec. 10, T. 159 N., R. 76 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; few fine and very fine roots; neutral; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; neutral; gradual wavy boundary.

Bw1—14 to 27 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; neutral; gradual wavy boundary.

Bw2—27 to 30 inches; brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; mildly alkaline; abrupt wavy boundary.

2BCk—30 to 40 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (2.5Y 7/2) dry; common medium prominent yellowish brown (10YR 5/8) mottles and common medium distinct light olive gray (5Y 6/2) mottles; massive; hard, firm, sticky and plastic; common medium irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

2C—40 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; common medium prominent gray (5Y 6/1) mottles and common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; strongly effervescent; moderately alkaline.

The depth to the 2BCk or 2C horizon ranges from 20 to 40 inches. The A horizon has value of 2 or 3 (3 or 4 dry). The Bw horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 6 dry), and chroma of 1 to 3. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is silt loam, silty clay loam, loam, or clay loam.

Tonka Series

The Tonka series consists of deep, poorly drained, slowly permeable soils on till plains and lacustrine plains. These soils formed in alluvium, glacial till, and glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Tonka silt loam, 2,385 feet south and 1,515 feet west of the northeast corner of sec. 14, T. 154 N., R. 80 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few coarse and medium roots; neutral; abrupt wavy boundary.

E—7 to 12 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) silt loam, gray (10YR 5/1) and light gray (10YR 6/1) dry; common fine distinct dark brown (10YR 4/3) mottles; moderate thin platy stucture; soft, very friable, slightly sticky and slightly plastic; many very fine and few coarse and medium roots; neutral; clear wavy boundary.

Btg1—12 to 25 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; common fine faint dark olive gray (5Y 3/2) mottles; moderate coarse prismatic structure parting to strong very fine and fine angular blocky; hard, firm, sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds; bleached sand grains on the top of prisms; neutral; clear wavy boundary.

Btg2—25 to 34 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; moderate coarse prismatic structure parting to strong very fine and fine angular blocky; hard, firm, sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds; mildly alkaline; clear wavy boundary.

Bkg—34 to 41 inches; olive gray (5Y 5/2) loam, light gray (2.5Y 7/2) dry; many medium distinct light olive brown (2.5Y 5/4) mottles; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

C—41 to 60 inches; grayish brown (2.5Y 5/2) loam, light gray (2.5Y 7/2) dry; many fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; about 5 percent gravel; strongly effervescent; mildly alkaline.

The A horizon has value of 2 or 3 (3 or 4 dry). The E horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 3 to 5 (5 to 7 dry) and chroma of 0 to 2. It is silt loam or loam. The Btg horizon has hue of 10YR to 5Y, value of 2 to 4 (4 to 6 dry), and chroma of 1 or 2. It is silty clay loam or clay loam. The C horizon has hue

of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Towner Series

The Towner series consists of deep, moderately well drained soils on windblown lacustrine plains and till plains. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. These soils formed in glaciofluvial deposits, glacial till, and glaciolacustrine deposits. Slope ranges from 0 to 6 percent.

Typical pedon of Towner loamy fine sand, 0 to 6 percent slopes, 150 feet south and 1,675 feet east of the northwest corner of sec. 26, T. 151 N., R. 76 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; neutral; clear smooth boundary.

A—10 to 19 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; neutral; clear wavy boundary.

Bw1—19 to 27 inches; dark brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; weak medium and fine subangular blocky structure; loose, nonsticky and nonplastic; common very fine roots; neutral; gradual wavy boundary.

2Bw2—27 to 35 inches; dark brown (10YR 4/3) loam, light yellowish brown (10YR 6/4) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; about 5 percent gravel; mildly alkaline; gradual wavy boundary.

2BCk—35 to 45 inches; brown (10YR 5/3) loam, pale brown (10YR 6/3) dry; massive; hard, firm, slightly sticky and slightly plastic; about 5 percent gravel; many fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear smooth boundary.

2C—45 to 60 inches; dark brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; common medium distinct olive gray (5Y 4/2) mottles; massive; hard, firm, sticky and plastic; about 5 percent gravel; slightly effervescent; moderately alkaline.

The depth to the 2B horizon ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 30 inches.

The Bw horizon has value of 3 or 4 (4 to 6 dry) and chroma of 2 to 4. The 2C horizon has hue of 10YR to 5Y, value of 4 to 6 (6 to 8 dry), and chroma of 2 to 4. It is silt loam, silty clay, clay, loam, or clay loam.

Ulen Series

The Ulen series consists of deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on windblown delta plains. These soils formed in glaciofluvial deposits. Slope ranges from 0 to 3 percent.

Typical pedon of Ulen fine sandy loam, 0 to 3 percent slopes, 1,775 feet east and 175 feet north of the southwest corner of sec. 34, T. 157 N., R. 76 W.

A—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; slightly effervescent; mildly alkaline; clear smooth boundary.

Ak—7 to 11 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine roots; disseminated lime throughout; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk1—11 to 21 inches; dark grayish brown (10YR 4/2) loamy fine sand, light brownish gray (10YR 6/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; common very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; clear smooth boundary.

Bk2—21 to 34 inches; brown (10YR 5/3) loamy fine sand, very pale brown (10YR 7/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; disseminated lime throughout; strongly effervescent; moderately alkaline; clear smooth boundary.

C—34 to 60 inches; light olive brown (2.5Y 5/4) fine sand, light yellowish brown (2.5Y 6/4) dry; common medium faint light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 10 to 20 inches. The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is fine sandy loam or

loamy fine sand. Some pedons do not have an Ak horizon. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 to 7 dry), and chroma of 1 to 3. It is loamy fine sand or fine sand. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (6 or 7 dry), and chroma of 2 to 6.

Velva Series

The Velva series consists of deep, well drained, moderately rapidly permeable soils on bottom land and terraces. These soils formed in loamy and silty alluvium. Slope ranges from 0 to 6 percent.

Typical pedon of Velva loam, 0 to 6 percent slopes, 1,500 feet west and 1,400 feet north of the southeast corner of sec. 7, T. 153 N., R. 80 W.

Oi—2 inches to 0; black (10YR 2/1) mostly undecomposed stems, leaves, and roots; neutral; abrupt smooth boundary.

A—0 to 5 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; many fine and very fine roots; neutral; clear smooth boundary.

Bw1—5 to 13 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak coarse prismatic structure parting to moderate medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; neutral; clear wavy boundary.

Bw2—13 to 20 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; moderately alkaline; clear wavy boundary.

Bw3—20 to 35 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; moderate medium and coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; moderately alkaline; abrupt smooth boundary.

Ab—35 to 41 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine irregularly shaped filaments and soft masses of lime; slightly effervescent; mildly alkaline; clear smooth boundary.

C—41 to 60 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine irregularly shaped filaments and soft masses of lime; slightly effervescent; moderately alkaline.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The Bw horizon has value of 3 to 4 (4 to 5 dry) and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 7 dry), and chroma of 2 to 4. Some pedons have more than one Ab horizon.

Verendrye Series

The Verendrye series consists of deep, poorly drained, rapidly permeable soils on outwash plains and delta plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Verendrye loamy coarse sand, 2,300 feet west and 1,325 feet south of the northeast corner of sec. 9, T. 154 N., R. 76 W.

A1—0 to 6 inches; black (10YR 2/1) loamy coarse sand, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; slightly effervescent; mildly alkaline; clear smooth boundary.

A2—6 to 10 inches; very dark gray (10YR 3/1) loamy coarse sand, dark gray (10YR 4/1) dry; few fine distinct dark brown (10YR 3/3) mottles; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—10 to 14 inches; dark grayish brown (2.5Y 4/2) coarse sand, light brownish gray (2.5Y 6/2) dry; few fine distinct olive brown (2.5Y 4/4) mottles; single grain; loose, nonsticky and nonplastic; common fine and very fine roots; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—14 to 20 inches; dark grayish brown (2.5Y 4/2) coarse sand, light gray (2.5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; common fine and very fine roots; about 2 percent gravel; slightly effervescent; mildly alkaline; gradual wavy boundary.

C3—20 to 34 inches; olive gray (5Y 5/2) coarse sand, light olive gray (5Y 6/2) dry; common fine prominent light olive brown (2.5Y 5/6) mottles; single grain; loose, nonsticky and nonplastic; few fine roots; about 1 percent gravel; slightly effervescent; mildly alkaline; gradual wavy boundary.

C4—34 to 60 inches; light brownish gray (2.5Y 6/2) coarse sand, light gray (2.5Y 7/2) dry; single grain; loose, nonsticky and nonplastic; about 1 percent gravel; slightly effervescent; mildly alkaline.

The thickness of the mollic epipedon ranges from 10 to 16 inches. The A horizon has hue of 10YR or 2.5Y, or it is neutral in hue. It has value of 2 or 3 (3 to 5 dry) and chroma of 0 or 1. Some pedons have an AC horizon. The C horizon has hue of 10YR to 5Y, or it is neutral in hue. It has value of 4 to 6 (6 or 7 dry) and chroma of 0 to 2. It is coarse sand, loamy coarse sand, loamy sand, or sand.

Williams Series

The Williams series consists of deep, well drained, moderately slowly permeable soils on till plains and moraines. These soils formed in glacial till. Slope ranges from 0 to 20 percent.

Typical pedon of Williams loam, 0 to 3 percent slopes, 800 feet south and 2,100 feet west of the northeast corner of sec. 19, T. 152 N., R. 80 W.

Ap—0 to 5 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; about 3 percent gravel; neutral; abrupt smooth boundary.

Bt1—5 to 11 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds; about 3 percent gravel; neutral; clear smooth boundary.

Bt2—11 to 18 inches; dark grayish brown (2.5Y 4/2) clay loam, grayish brown (2.5Y 5/2) dry; moderate medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, sticky and plastic; common very fine roots; continuous distinct clay films on faces of peds; about 3 percent gravel; neutral; clear wavy boundary.

Btk—18 to 35 inches; dark grayish brown (2.5Y 4/2) clay loam, light brownish gray (2.5Y 6/2) dry; weak medium prismatic structure parting to moderate medium and coarse subangular blocky; hard, firm, sticky and plastic; common very fine roots; common faint clay films on faces of peds; about 3 percent gravel; many medium irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk—35 to 47 inches; dark grayish brown (2.5Y 4/2) clay loam, pale yellow (2.5Y 7/4) dry; moderate coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; few medium irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1—47 to 57 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; few fine masses of gypsum crystals; slightly effervescent; moderately alkaline; gradual wavy boundary.

C2—57 to 60 inches; dark grayish brown (2.5Y 4/2) loam, light brownish gray (2.5Y 6/2) dry; weak medium and coarse subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; common fine masses of gypsum crystals; slightly effervescent; moderately alkaline.

The gravel content is 1 to 10 percent throughout the profile. The A horizon has value of 2 or 3 (3 to 5 dry). The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 or 3. It is loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 2 to 4. It is loam or clay loam.

Wyndmere Series

The Wyndmere series consists of deep, somewhat poorly drained, moderately rapidly permeable, highly calcareous soils on delta plains and lacustrine plains. These soils formed in glaciofluvial deposits and glaciolacustrine deposits. Slope is 0 to 1 percent.

Typical pedon of Wyndmere fine sandy loam, 250 feet west and 1,150 feet south of the northeast corner of sec. 2, T. 158 N., R. 75 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and common very fine and fine roots; slightly effervescent; moderately alkaline; gradual smooth boundary.

Bk1—9 to 25 inches; light brownish gray (10YR 6/2) fine sandy loam, white (10YR 8/2) dry; weak medium subangular blocky structure; slightly hard,

friable, slightly sticky and slightly plastic; few very fine roots; disseminated lime throughout; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—25 to 39 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; few fine distinct yellowish brown (10YR 5/6) mottles and common fine distinct light brownish gray (2.5Y 6/2) mottles; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; clear smooth boundary.

C1—39 to 48 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; many large distinct yellowish brown (10YR 5/6) mottles and common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; soft, very friable, nonsticky and slightly plastic; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; many fine distinct yellowish brown (10YR 5/6) mottles and many medium distinct olive gray (5Y 5/2) mottles; single grain; soft, very friable, nonsticky and nonplastic; strongly effervescent; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The A horizon has value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 6 (4 to 8 dry), and chroma of 1 to 3. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. Some pedons have a 2C horizon at a depth of 40 to 60 inches. It is loam, silt loam, or silty clay loam. Some pedons are saline.

Wyrene Series

The Wyrene series consists of deep, somewhat poorly drained, rapidly permeable, highly calcareous soils on delta plains and outwash plains. These soils formed in glaciofluvial deposits. Slope is 0 to 1 percent.

Typical pedon of Wyrene sandy loam, 2,350 feet south and 1,400 feet west of the northeast corner of sec. 26, T. 157 N., R. 80 W.

A—0 to 3 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; about 1 percent gravel; slightly effervescent; moderately alkaline; clear smooth boundary.

Ak—3 to 13 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; about 1 percent gravel; disseminated lime throughout; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk1—13 to 24 inches; dark grayish brown (2.5Y 4/2) sandy loam, light brownish gray (2.5Y 6/2) dry; few fine faint brown (10YR 4/3) mottles; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 2 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; clear smooth boundary.

Bk2—24 to 28 inches; grayish brown (2.5Y 5/2) sandy loam, light brownish gray (2.5Y 6/2) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; few very fine roots; about 5 percent gravel; disseminated lime throughout; violently effervescent; moderately alkaline; abrupt smooth boundary.

2C1—28 to 40 inches; olive brown (2.5Y 4/4) gravelly coarse sand, light olive brown (2.5Y 5/4) dry; single grain; loose, nonsticky and nonplastic; about 20 percent gravel; slightly effervescent; moderately alkaline; clear smooth boundary.

2C2—40 to 60 inches; yellowish brown (10YR 5/4) coarse sand, light yellowish brown (10YR 6/4) dry; single grain; loose, nonsticky and nonplastic; about 5 percent gravel; very slightly effervescent; moderately alkaline.

The mollic epipedon ranges from 7 to 16 inches thick. The depth to gravelly coarse sand or stratified sand and gravel ranges from 20 to 32 inches.

The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 to 7 dry), and chroma of 1 or 2. It is sandy loam or coarse sandy loam. The 2C horizon has hue of 10YR to 5Y, value of 3 to 6 (5 to 8 dry), and chroma of 1 to 4. It is gravelly coarse sand, coarse sand, sand, or stratified sand and gravel.

Zahl Series

The Zahl series consists of deep, well drained,

moderately slowly permeabile soils on till plains and moraines. These soils formed in glacial till. Slopes range from 6 to 60 percent.

Typical pedon of Zahl loam, in an area of Williams-Zahl loams, 6 to 9 percent slopes, 1,100 feet north and 1,600 feet west of the southeast corner of sec. 22, T. 152 N., R. 80 W.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine roots; about 5 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk—5 to 20 inches; dark grayish brown (2.5Y 4/2) loam, light gray (2.5Y 7/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, firm, sticky and plastic; few fine roots; about 5 percent gravel; many medium irregularly shaped soft masses of lime; violently effervescent; moderately alkaline; gradual wavy boundary.

C—20 to 60 inches; grayish brown (2.5Y 5/2) loam, light brownish gray (2.5Y 6/2) dry; massive; hard, firm, sticky and plastic; few fine roots; about 5 percent gravel; common medium irregularly shaped soft masses of lime; strongly effervescent; moderately alkaline.

The mollic epipedon ranges from 7 to 10 inches thick. The A horizon has hue of 10YR or 2.5Y and value of 2 or 3 (3 to 5 dry). The Bk horizon has hue of 10YR or 2.5Y, value of 4 to 6 (4 to 7 dry), and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 to 4. It is loam or clay loam.

Formation of the Soils

The formation of soils is a dynamic process. It is the product of five major soil forming factors. They are: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil formed; (3) the plant and animal life on and in the soil; (4) the relief; and (5) the length of time these factors have acted on the soil material.

Climate, plant life, and, to a lesser degree, animal life are the active factors that affect the soil forming process. They act on the parent material by determining the nature of weathering and slowly transform the parent material into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by the relief and the parent material. Time is required for the climatic and biological forces to change the parent material and for soil to form. A long time generally is required for distinct horizons to develop.

The factors of soil formation are so closely interrelated in their effects on the soil that few general statements can be made about the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in McHenry County formed in glacial materials derived from preglacial rock. As the glacier advanced, it picked up this rock, ground and mixed it, and transported it many miles from its place of origin.

Glacial till is the unsorted material that was deposited directly by the glacier. Barnes and Williams soils developed in glacial till. As the glacier melted and receded, some glacial materials were washed and sorted by the combination of meltwater and large amounts of rainfall to form glacial outwash. Falsen and Lohnes soils developed in glaciofluvial deposits.

Glacial Lake Souris formed in the northern and eastern parts of the county, where the Souris River was dammed by the receding glacier. Well sorted glacial lacustrine sediment was deposited by the quiet waters of glacial Lake Souris. Gardena and Great Bend soils developed in glaciolacustrine deposits.

Deltas formed wherever outwash channels emptied into glacial Lake Souris. These materials were sorted by water and were later sorted by wind. Aylmer and Hecla soils formed in windblown deltaic glaciofluvial deposits.

Alluvium was deposited on the flood plain along the Souris River and other streams during periods of flooding. Ludden and Velva soils formed in alluvium.

Climate

Climate has direct and indirect effects on the formation of soils. Precipitation, temperature, and wind directly affect the weathering and reworking of parent material. Climate indirectly affects soil formation through its effects on the amount and kind of vegetation and animal life on or in the soil.

McHenry County has a dry-subhumid to semiarid climate that is characterized by long, cold winters and short, warm summers. Most precipitation occurs during the growing season, but it is erratic at times. This type of climate encourages a dominance of mechanical processes of weathering, such as freezing and thawing, that reduce particle size but effect little change in chemical composition.

In addition to weathering parent materials, precipitation and temperature affect the leaching and redistribution of carbonates and clay particles and the accumulation of organic matter in the soil. Cool temperatures affect the content of organic matter by slowing the decay of plant material and animal remains.

Plant and Animal Life

The soils in McHenry County formed mainly under mid and tall grass prairies. The fibrous roots of grasses penetrate the soil to a depth of several feet, making it more porous and more granular. As a result, more water enters the soil and becomes available for increased microbiological activity. The decomposition of plants by micro-organisms increases the organic matter content, and over long periods of time it gives the surface layer its dark color. It also replaces nutrients

Figure 11.—Typical profile of Divide loam. The light color of the subsoil, between depths of 6 and 28 inches, is the result of lime rising with capillary water.

lost from the surface layer by leaching.

Earthworms and burrowing animals help to mix the soil material, transfer organic matter below the surface, and increase porosity.

Human activities can have an important impact on soil formation. Man has altered drainage and changed types of vegetation. Man can also maintain the soil that has formed by maintaining fertility and controlling erosion.

Relief

Relief influences the formation of soils through its effect on runoff and drainage. The slope of soils in McHenry County ranges from level to very steep.

In areas where slopes are steeper, most of the precipitation is lost as runoff. Therefore, vegetation is sparse, leaching is minimal, and profile development is thin, as in the Buse soils. Svea and other soils on foot slopes and in swales receive more moisture because of their position on the landscape; therefore, they are leached to a greater degree and have a more deeply developed soil profile.

Soils that formed in depressional areas and on flats vary widely in profile development, depending on the degree of wetness. Tonka soils, which are in shallow depressional areas, exhibit an advanced degree of horizonation because of the alternate wet and dry cycles that occur in these areas. Parnell soils, which are in deep depressional areas, exhibit a lesser degree of horizonation because they are ponded for longer periods and are exposed to fewer dry periods. Divide soils, which are mostly on flats, have an accumulation of lime in the upper part of the profile (fig. 11). The lime moves to the surface with the seasonal high water table and through capillary action. The water is removed by evaporation and transpiration, which results in the accumulation of lime in the surface layer and subsoil.

Time

A long time is required for the soil forming factors to act on parent material and form a soil profile with distinct horizons. The soils in McHenry County generally are about 12,000 years old or younger, since this is approximately when the glacier finally receded. On a geologic time scale, the soils in the county are very young.

Both Aylmer and Hecla soils formed on outwash plains and delta plains; however, the Hecla soils have well defined horizons and a higher organic matter content than the Aylmer soils. This is due in part to the difference in time of development. The soil forming factors have been continually acting on the parent material of the Hecla soils, but the parent material of the Aylmer soils has been more recently reworked by wind, resulting in less time for profile development.

The Minnewaukan soils have had very little time in

which to develop. During the drought of the 1930's, some areas of Aylmer and Hecla soils that were being cultivated or continually overgrazed were severely damaged by soil blowing. In some areas the soil was blown out to the depth of the water table. In the last 50 years, these areas have revegetated under more favorable climatic conditions. Exposed water remains at the surface or slightly above the surface. The development of the Minnewaukan soils has been minimal, resulting in only a 3-inch-thick surface layer developing in the parent material. This thin surface layer is the result of the addition of organic matter.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather

than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a

combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*,

more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mulch tillage. Preparation of the soil in such a way that plant residue or other mulching material is left on or near the surface.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

No-till. A method of planting crops that involves no seedbed preparation other than opening the soil for the purpose of placing the seed.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root shearing. The cutting, tearing, and disruption of plant roots caused by animals grazing when the soil is wet and soft.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters).

Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Granville, North Dakota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	15.4	-5.9	4.8	45	-34	0	0.46	0.15	0.70	2	6.9
February----	23.2	1.4	12.3	49	-31	0	.41	.05	.67	1	4.8
March-------	35.1	13.5	24.3	66	-23	55	.59	.17	.91	2	5.4
April-------	53.9	28.9	41.4	85	5	168	1.50	.40	2.39	4	3.7
May---------	68.3	40.6	54.5	93	21	454	2.19	1.04	3.18	5	.1
June--------	76.5	50.3	63.4	96	33	702	3.34	1.61	4.83	7	.0
July--------	83.4	55.4	69.4	101	40	911	2.04	.94	2.97	5	.0
August------	82.5	52.9	67.7	101	36	859	2.39	.94	3.59	5	.0
September---	70.6	42.9	56.8	96	23	504	1.79	.52	2.83	4	.1
October-----	58.6	32.5	45.6	87	12	232	.84	.23	1.34	2	1.4
November----	38.0	17.3	27.7	67	-13	36	.45	.12	.73	2	4.1
December----	23.6	3.5	13.6	51	-31	13	.46	.18	.69	2	5.2
Yearly:											
Average---	52.4	28.3	40.1	---	---	---	---	---	---	---	---
Extreme---	---	---	---	102	-35	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,934	16.46	13.67	19.35	41	31.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Granville, North Dakota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 13	May 28	June 7
2 years in 10 later than--	May 7	May 23	June 1
5 years in 10 later than--	Apr. 27	May 13	May 21
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 21	Sept. 14	Aug. 19
2 years in 10 earlier than--	Sept. 27	Sept. 19	Aug. 28
5 years in 10 earlier than--	Oct. 7	Sept. 27	Sept. 12

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Granville, North Dakota)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	144	117	79
8 years in 10	150	124	91
5 years in 10	162	137	113
2 years in 10	173	150	136
1 year in 10	180	156	148

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Tonka silt loam	4,960	0.4
2	Parnell silty clay loam	6,210	0.5
5	Southam silt loam	6,650	0.5
6	Rifle mucky peat	3,190	0.3
10	Aberdeen-Great Bend complex, 0 to 3 percent slopes	1,330	0.1
17B	Arvilla sandy loam, 0 to 6 percent slopes	22,770	1.9
18B	Aylmer-Bantry fine sands, 0 to 6 percent slopes	103,060	8.3
19B	Aylmer-Minnewaukan complex, 0 to 6 percent slopes	5,870	0.5
24B	Barnes-Buse loams, 3 to 6 percent slopes	21,950	1.8
24C	Barnes-Buse loams, 6 to 9 percent slopes	22,750	1.9
24D	Buse-Barnes loams, 9 to 15 percent slopes	8,950	0.7
24E	Buse-Barnes loams, 15 to 25 percent slopes	7,380	0.6
29	Svea-Barnes loams, 0 to 2 percent slopes	7,770	0.6
29B	Barnes-Svea loams, 2 to 5 percent slopes	93,890	7.7
36	Miranda-Cavour loams	6,110	0.5
37	Cavour-Cresbard loams, 0 to 3 percent slopes	8,530	0.7
44B	Claire-Lohnes coarse sands, 1 to 6 percent slopes, hummocky	6,240	0.5
50	Colvin silt loam	7,020	0.6
51	Colvin silt loam, saline	3,380	0.3
52	Colvin silt loam, wet	2,580	0.2
54	Barnes-Cresbard loams, 0 to 3 percent slopes	24,960	2.0
54B	Barnes-Cresbard loams, 3 to 6 percent slopes	18,720	1.5
56	Divide loam, 0 to 3 percent slopes	3,320	0.3
62B	Egeland fine sandy loam, 0 to 6 percent slopes	8,720	0.7
65	Embden fine sandy loam, 0 to 3 percent slopes	25,700	2.1
68	Fargo silty clay	950	0.1
72	Verendrye loamy coarse sand	8,660	0.7
73	Fossum and Arveson soils	33,900	2.8
74	Fossum fine sandy loam, wet	10,790	0.9
76	Gardena loam, 0 to 3 percent slopes	8,360	0.7
79	Glyndon loam, saline	4,770	0.4
80	Glyndon loam	14,100	1.1
82	Great Bend-Overly complex, 0 to 3 percent slopes	5,920	0.5
88	Hamerly loam, saline, 0 to 3 percent slopes	3,820	0.3
89	Hamerly loam, 0 to 3 percent slopes	3,800	0.3
90	Hamerly-Tonka complex, 0 to 3 percent slopes	14,820	1.2
91	Hecla loamy fine sand, 0 to 3 percent slopes	98,310	7.9
104	Colvin silt loam, channeled	4,490	0.4
105	Letcher fine sandy loam, 0 to 3 percent slopes	1,570	0.1
106	Swenoda-Larson fine sandy loams, 0 to 3 percent slopes	8,070	0.7
106B	Swenoda-Larson fine sandy loams, 3 to 6 percent slopes	7,130	0.6
107B	Lohnes-Claire coarse sands, 0 to 6 percent slopes	55,800	4.6
108	Falsen-Karlsruhe complex, 0 to 3 percent slopes	28,780	2.4
109D	Lohnes and Maddock soils, 6 to 15 percent slopes	5,980	0.5
110	Ludden clay, ponded	13,310	1.1
111	Ludden clay	23,620	1.9
112B	Maddock-Hecla loamy fine sands, 1 to 6 percent slopes	25,030	2.0
124	Marysland silt loam	4,310	0.3
127	Pits, gravel	740	0.1
136	Ryan loam	5,390	0.4
137	Harriet silt loam	15,280	1.3
139F	Serden sand, 3 to 50 percent slopes	20,040	1.6
145B	Sioux gravelly sandy loam, 1 to 6 percent slopes	7,940	0.7
145E	Sioux gravelly sandy loam, 6 to 25 percent slopes	4,980	0.4
151	Stirum fine sandy loam	30,200	2.5
157	Swenoda fine sandy loam, 0 to 3 percent slopes	17,700	1.4
158B	Swenoda-Barnes complex, 0 to 6 percent slopes	24,070	2.0
163B	Towner loamy fine sand, 0 to 6 percent slopes	42,070	3.4
164C	Towner-Buse-Maddock complex, 3 to 9 percent slopes	10,740	0.9
165E	Dickey-Buse-Maddock complex, 9 to 25 percent slopes	9,530	0.8
172	Ulen fine sandy loam, 0 to 3 percent slopes	50,580	4.1
175	Ulen-Hecla loamy fine sands, 0 to 3 percent slopes	32,740	2.7
176B	Velva loam, 0 to 6 percent slopes	4,680	0.4
177	LaDelle silty clay loam, 0 to 3 percent slopes	2,230	0.2

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
180	Wyndmere fine sandy loam, saline	4,400	0.4
181	Wyndmere fine sandy loam	23,000	1.9
184	Wyrene sandy loam	4,680	0.4
185	Karlsruhe coarse sandy loam	15,180	1.2
186	Williams loam, 0 to 3 percent slopes	21,280	1.7
186B	Williams loam, 3 to 6 percent slopes	14,450	1.2
187C	Williams-Zahl loams, 6 to 9 percent slopes	8,430	0.7
188E	Zahl-Williams loams, 9 to 20 percent slopes	5,960	0.5
188F	Zahl-Max-Svea loams, 6 to 60 percent slopes	8,100	0.7
189	Williams-Niobell loams, 0 to 3 percent slopes	2,610	0.2
189B	Williams-Niobell loams, 3 to 6 percent slopes	1,650	0.1
	Water	16,850	1.4
	Total	1,223,800	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management, except the undrained yield is given for poorly drained and very poorly drained soils. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
1------------------------- Tonka	16	34	26	8	20	800	2.7
2------------------------- Parnell	---	---	---	---	---	---	2.8
5. Southam							
6. Rifle							
10------------------------ Aberdeen-Great Bend	33	70	54	17	42	1,650	2.0
17B----------------------- Arvilla	14	30	23	7	18	700	1.7
18B----------------------- Aylmer-Bantry	---	---	---	---	---	---	1.6
19B----------------------- Aylmer-Minnewaukan	---	---	---	---	---	---	1.6
24B----------------------- Barnes-Buse	27	57	44	14	34	1,350	2.2
24C----------------------- Barnes-Buse	20	42	32	10	25	1,000	2.1
24D----------------------- Buse-Barnes	---	---	---	---	---	---	1.8
24E----------------------- Buse-Barnes	---	---	---	---	---	---	1.8
29------------------------ Svea-Barnes	35	74	57	17	45	1,750	2.7
29B----------------------- Barnes-Svea	32	68	52	16	41	1,600	2.6
36------------------------ Miranda-Cavour	---	---	---	---	---	---	1.1
37------------------------ Cavour-Cresbard	18	38	29	9	23	900	1.5
44B----------------------- Claire-Lohnes	---	---	---	---	---	---	1.8
50------------------------ Colvin	15	32	24	7	19	750	2.8
51------------------------ Colvin	10	21	16	5	13	500	2.1

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
52. Colvin							
54 Barnes-Cresbard	31	66	50	15	39	1,500	2.1
54B Barnes-Cresbard	28	59	45	14	36	1,400	2.1
56 Divide	25	53	41	12	32	1,250	2.3
62B Egeland	23	49	37	11	29	1,150	2.1
65 Embden	30	64	49	15	38	1,500	1.9
68 Fargo	35	74	57	17	45	1,750	2.7
72 Verendrye	10	21	16	5	13	500	2.8
73 Fossum and Arveson	12	25	19	6	15	600	2.7
74 Fossum	---	---	---	---	---	---	1.4
76 Gardena	39	83	63	19	50	1,950	2.5
79 Glyndon	24	51	39	12	31	1,200	2.1
80 Glyndon	37	79	60	18	47	1,850	2.3
82 Great Bend-Overly	36	76	58	18	46	1,800	2.7
88 Hamerly	20	42	32	10	25	1,000	2.0
89 Hamerly	32	68	52	16	41	1,600	2.3
90 Hamerly-Tonka	27	57	44	14	34	1,350	2.5
91 Hecla	20	42	32	10	25	1,000	1.8
104 Colvin	---	---	---	---	---	---	1.3
105 Letcher	10	21	16	5	13	500	1.4
106 Swenoda-Larson	23	49	37	11	29	1,150	1.8

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
106B----------------------- Swenoda-Larson	20	42	32	10	25	1,000	1.8
107B----------------------- Lohnes-Claire	---	---	---	---	---	---	1.8
108------------------------ Falsen-Karlsruhe	---	---	---	---	---	---	1.6
109D----------------------- Lohnes and Maddock	---	---	---	---	---	---	1.9
110. Ludden							
111------------------------ Ludden	15	32	24	8	19	750	2.7
112B----------------------- Maddock-Hecla	16	34	26	8	20	800	1.8
124------------------------ Marysland	16	34	26	8	20	800	2.8
127*. Pits							
136------------------------ Ryan	---	23	18	5	---	---	1.0
137------------------------ Harriet	---	---	---	---	---	---	1.6
139F. Serden							
145B, 145E----------------- Sioux	---	---	---	---	---	---	0.9
151------------------------ Stirum	---	---	---	---	---	---	1.6
157------------------------ Swenoda	31	66	50	15	39	1,550	2.1
158B----------------------- Swenoda-Barnes	28	59	45	14	36	1,400	2.2
163B----------------------- Towner	20	42	32	10	25	1,000	1.8
164C----------------------- Towner-Buse-Maddock	15	32	24	7	19	750	1.5
165E. Dickey-Buse-Maddock							
172------------------------ Ulen	23	49	37	11	29	1,150	2.3

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Spring wheat	Oats	Barley	Flax	Rye	Sunflowers	Bromegrass-alfalfa hay
	Bu	Bu	Bu	Bu	Bu	Lbs	Tons
175----------------------- Ulen-Hecla	20	42	32	10	25	1,000	2.2
176B---------------------- Velva	27	57	44	13	34	1,350	2.6
177----------------------- LaDelle	38	81	62	19	48	1,900	2.8
180----------------------- Wyndmere	18	38	29	9	23	900	2.1
181----------------------- Wyndmere	27	57	44	13	34	1,350	2.3
184----------------------- Wyrene	19	40	31	9	24	950	2.3
185----------------------- Karlsruhe	19	40	31	9	24	950	2.3
186----------------------- Williams	34	72	55	17	43	1,700	2.3
186B---------------------- Williams	30	64	49	15	38	1,500	2.2
187C---------------------- Williams-Zahl	19	40	31	9	24	950	1.8
188E---------------------- Zahl-Williams	---	---	---	---	---	---	1.7
188F. Zahl-Max-Svea							
189----------------------- Williams-Niobell	30	64	49	15	38	1,500	1.8
189B---------------------- Williams-Niobell	30	64	49	15	38	1,500	1.9

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
1----- Tonka	Wet Meadow-----	4,400	4,100	3,600
2----- Parnell	Wetland-----	6,300	5,700	4,600
10*:				
Aberdeen-----	Clayey-----	2,700	2,300	1,900
Great Bend-----	Silty-----	2,800	2,400	2,000
17B----- Arvilla	Shallow to Gravel-----	2,200	1,900	1,700
18B*:				
Aylmer-----	Sands-----	3,100	2,700	2,300
Bantry-----	Subirrigated Sands-----	3,700	3,200	2,500
19B*:				
Aylmer-----	Sands-----	3,100	2,700	2,300
Minnewaukan-----	Subirrigated-----	4,400	4,000	3,500
24B*, 24C*:				
Barnes-----	Silty-----	2,800	2,450	2,100
Buse-----	Thin Upland-----	2,400	2,100	1,600
24D*, 24E*:				
Buse-----	Thin Upland-----	2,400	2,100	1,600
Barnes-----	Silty-----	2,800	2,450	2,100
29*:				
Svea-----	Overflow-----	3,500	3,100	2,700
Barnes-----	Silty-----	2,800	2,450	2,100
29B*:				
Barnes-----	Silty-----	2,800	2,450	2,100
Svea-----	Silty-----	2,800	2,400	2,100
36*:				
Miranda-----	Thin Claypan-----	1,300	1,100	900
Cavour-----	Claypan-----	2,200	2,000	1,700
37*:				
Cavour-----	Claypan-----	2,200	2,000	1,700
37*:				
Cresbard-----	Clayey-----	3,000	2,700	2,300

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season: Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
44B*:				
Claire	Thin Sands	2,100	1,800	1,500
Lohnes	Sands	3,100	2,600	2,300
50 Colvin	Wet Meadow	5,000	4,600	4,300
51 Colvin	Saline Lowland	4,000	3,500	3,000
52 Colvin	Wetland	6,200	5,700	5,200
54*, 54B*:				
Barnes	Silty	3,000	2,750	2,500
Cresbard	Clayey	3,000	2,700	2,300
56 Divide	Limy Subirrigated	4,200	3,800	3,200
62B Egeland	Sandy	2,900	2,500	2,100
65 Embden	Sandy	3,100	2,700	2,200
68 Fargo	Clayey	3,200	2,700	2,300
72 Verendrye	Subirrigated	4,600	4,000	3,400
73*:				
Fossum	Subirrigated	4,500	4,100	3,700
Arveson	Subirrigated	4,600	4,100	3,600
74 Fossum	Wetland	6,400	5,800	5,200
76 Gardena	Silty	2,800	2,500	2,100
79 Glyndon	Saline Lowland	4,000	3,500	3,000
80 Glyndon	Limy Subirrigated	4,200	3,800	3,200
82*:				
Great Bend	Silty	2,800	2,400	2,000
Overly	Silty	2,800	2,400	2,100
88 Hamerly	Saline Lowland	4,000	3,500	3,000

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable Lb/acre	Average Lb/acre	Unfavorable Lb/acre
89 Hamerly	Limy Subirrigated	4,200	3,800	3,200
90*:				
Hamerly	Limy Subirrigated	4,200	3,800	3,200
Tonka	Wet Meadow	4,400	4,100	3,600
91 Hecla	Sands	3,100	2,700	2,300
104 Colvin	Wet Meadow	4,400	4,100	3,600
105 Letcher	Sandy Claypan	3,800	2,800	1,800
106*, 106B*:				
Swenoda	Sandy	3,200	2,800	2,500
Larson	Claypan	2,200	1,900	1,700
107B*:				
Lohnes	Sands	3,100	2,600	2,300
Claire	Thin Sands	2,100	1,800	1,500
108*:				
Falsen	Sands	3,100	2,700	2,300
Karlsruhe	Limy Subirrigated	4,400	3,800	3,200
109D*:				
Lohnes	Sands	3,100	2,600	2,300
Maddock	Sands	3,100	2,700	2,300
111 Ludden	Overflow	3,500	3,100	2,700
112B*:				
Maddock	Sands	3,100	2,700	2,300
Hecla	Sands	3,100	2,700	2,300
124 Marysland	Subirrigated	4,600	4,100	3,600
136 Ryan	Thin Claypan	1,100	900	700
137 Harriet	Saline Lowland	3,800	3,300	2,800
139F Serden	Thin Sands	2,100	1,800	1,500
145B, 145E Sioux	Very Shallow	1,000	800	600

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
151 Stirum	Subirrigated	4,400	4,000	3,500
157 Swenoda	Sandy	2,900	2,500	2,100
158B*:				
Swenoda	Sandy	3,200	2,800	2,500
Barnes	Silty	3,000	2,750	2,500
163B Towner	Sands	3,100	2,700	2,300
164C*:				
Towner	Sands	3,000	2,800	2,600
Buse	Thin Upland	2,700	2,400	1,800
Maddock	Sands	3,000	2,800	2,600
165E*:				
Dickey	Sands	3,000	2,800	2,600
Buse	Thin Upland	2,700	2,400	1,800
Maddock	Sands	3,000	2,800	2,600
172 Ulen	Limy Subirrigated	3,000	2,600	2,200
175*:				
Ulen	Limy Subirrigated	3,000	2,600	2,200
Hecla	Sands	3,100	2,700	2,300
176B Velva	Sandy	3,000	2,600	2,200
177 LaDelle	Overflow	3,500	3,100	2,600
180 Wyndmere	Saline Lowland	3,200	2,800	2,400
181 Wyndmere	Limy Subirrigated	4,200	3,800	3,200
184 Wyrene	Limy Subirrigated	4,200	3,800	3,200
185 Karlsruhe	Limy Subirrigated	4,400	3,800	3,200
186, 186B Williams	Silty	3,000	2,600	2,100

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
187C*:				
Williams	Silty	3,000	2,600	2,100
Zahl	Thin Upland	2,400	2,100	1,800
188E*:				
Zahl	Thin Upland	2,400	2,100	1,800
Williams	Silty	3,000	2,600	2,100
188F*:				
Zahl	Thin Upland	2,400	2,100	1,800
Max	Silty	3,000	2,500	2,100
Svea	Silty	3,000	2,700	2,500
189*, 189B*:				
Williams	Silty	3,000	2,600	2,100
Niobell	Clayey	2,800	2,400	2,000

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil or that trees are not commonly planted on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1. Tonka	---	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.
2. Parnell					
5. Southam					
6. Rifle					
10*:					
Aberdeen	---	Common chokecherry, eastern redcedar, American plum, Amur honeysuckle, Siberian peashrub, lilac.	Green ash, ponderosa pine, bur oak, Manchurian crabapple, Russian olive, Black Hills spruce.	---	---
Great Bend	---	Eastern redcedar, lilac, Manchurian crabapple, Amur honeysuckle, Siberian peashrub, American plum, common chokecherry.	Green ash, bur oak, ponderosa pine, Black Hills spruce, Russian olive.	---	---
17B. Arvilla	Amur honeysuckle, Siberian peashrub, lilac, silver buffaloberry.	Green ash, Russian olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry.	Ponderosa pine	---	---
18B*: Aylmer.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
18B*:					
Bantry	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
19B*:					
Aylmer.					
Minnewaukan	American plum	Lilac, Amur honeysuckle, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
24B*, 24C*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
24D*:					
Buse.					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
24E*:					
Buse.					
Barnes.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
29*:					
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
29B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
Svea	---	Redosier dogwood, ponderosa pine, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Black Hills spruce, blue spruce, green ash, eastern redcedar.	Golden willow	Eastern cottonwood.
36*:					
Miranda.					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
37*:					
Cavour	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
37*:					
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
44B*:					
Claire.					
Lohnes	---	Siberian peashrub, eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, silver buffaloberry, Amur honeysuckle.	Green ash, ponderosa pine, Russian olive, bur oak.	---	---
50 Colvin	---	American plum, Siberian peashrub, common chokecherry, lilac, eastern redcedar, redosier dogwood, Amur honeysuckle.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood.
51. Colvin					
52 Colvin	---	American plum, Siberian peashrub, Amur honeysuckle, eastern redcedar, redosier dogwood, lilac.	Green ash, Black Hills spruce, Siberian crabapple.	Golden willow	Eastern cottonwood, Siberian elm.
54*, 54B*:					
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
54*, 54B*:					
Cresbard	Amur honeysuckle, Peking cotoneaster.	Russian olive, common chokecherry, eastern redcedar, silver buffaloberry, Siberian peashrub, lilac.	Green ash, ponderosa pine, Siberian elm, Siberian crabapple.	---	---
56 Divide	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
62E Egeland	Silver buffaloberry, Amur honeysuckle.	Manchurian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
65 Embden	---	Peking cotoneaster, ponderosa pine, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub, Amur honeysuckle, American plum.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
68 Fargo	American plum	Eastern redcedar, lilac, common chokecherry, redosier dogwood, Siberian peashrub, Amur honeysuckle.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
72-----------------Verendrye	American plum-----	Common chokecherry, redosier dogwood, lilac, Siberian peashrub, eastern redcedar, Amur honeysuckle.	Siberian crabapple, Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
73*:					
Fossum.					
Arveson.					
74. Fossum					
76-----------------Gardena	---	Amur honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, common chokecherry, Siberian peashrub, American plum.	Green ash, Black Hills spruce.	Golden willow-----	Eastern cottonwood.
79-----------------Glyndon	Silver buffaloberry, Siberian peashrub.	---	Siberian elm, green ash, Russian olive.	---	---
80-----------------Glyndon	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
82*:					
Great Bend-------	---	Eastern redcedar, lilac, Manchurian crabapple, Amur honeysuckle, Siberian peashrub, American plum, common chokecherry.	Green ash, bur oak, ponderosa pine, Black Hills spruce, Russian olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
82*:					
Overly	---	Amur honeysuckle, ponderosa pine, Peking cotoneaster, redosier dogwood, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
88 Hamerly	Silver buffaloberry, Siberian peashrub.	---	Russian olive, green ash, Siberian elm.	---	---
89 Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
90*:					
Hamerly	---	Redosier dogwood, ponderosa pine, Amur honeysuckle, Peking cotoneaster, eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
Tonka	---	Eastern redcedar, common chokecherry, lilac, Amur honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Green ash, Siberian crabapple, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
91----- Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow-----	Eastern cottonwood.
104. Colvin					
105----- Letcher	Green ash, silver buffaloberry, Russian olive, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Amur honeysuckle, lilac.	Siberian elm, ponderosa pine.	---	---	---
106*, 106B*:					
Swenoda-----	Amur honeysuckle.	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, silver buffaloberry, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
Larson-----	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
107B*:					
Lohnes-----	---	Siberian peashrub, eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, silver buffaloberry, Amur honeysuckle.	Green ash, ponderosa pine, Russian olive, bur oak.	---	---
Claire.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
108*:					
Falsen	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
Karlsruhe	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
109D*:					
Lohnes	---	Siberian peashrub, eastern redcedar, Siberian crabapple, common chokecherry, American plum, lilac, silver buffaloberry, Amur honeysuckle.	Green ash, ponderosa pine, Russian olive, bur oak.	---	---
Maddock	---	Rocky Mountain juniper, eastern redcedar, ponderosa pine.	---	---	---
110. Ludden					
111 Ludden	---	Eastern redcedar, lilac, redosier dogwood, Amur honeysuckle, American plum, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
112B*:					
Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Amur honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian olive.	---	---
Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
124. Marysland					
127*. Pits					
136 Ryan	Rocky Mountain juniper, Siberian peashrub, silver buffaloberry.	Siberian elm, green ash, ponderosa pine, Russian olive, eastern redcedar.	---	---	---
137. Harriet					
139F. Serden					
145B, 145E. Sioux					
151. Stirum					
157 Swenoda	Amur honeysuckle.	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, silver buffaloberry, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
158B*:					
Swenoda	Amur honeysuckle.	Siberian crabapple, eastern redcedar, common chokecherry, Siberian peashrub, silver buffaloberry, lilac, American plum.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
Barnes	---	Eastern redcedar, American plum, lilac, Siberian peashrub, redosier dogwood, Amur honeysuckle.	Siberian crabapple, bur oak, green ash, ponderosa pine, Black Hills spruce, Russian olive.	---	---
163B Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum, silver buffaloberry, Siberian crabapple.	Ponderosa pine, green ash, Russian olive, bur oak.	---	---
164C*:					
Towner	---	Lilac, eastern redcedar, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum, silver buffaloberry, Siberian crabapple.	Ponderosa pine, green ash, Russian olive, bur oak.	---	---
Buse	Siberian peashrub, Amur honeysuckle, lilac.	Ponderosa pine, Russian olive, eastern redcedar, Rocky Mountain juniper.	Siberian elm, green ash.	---	---
Maddock	---	Rocky Mountain juniper, eastern redcedar, ponderosa pine.	---	---	---
165E*:					
Dickey.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
165E*: Buse.					
Maddock.					
172 Ulen	Amur honeysuckle.	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
175*: Ulen	Amur honeysuckle.	Eastern redcedar, Siberian crabapple, common chokecherry, lilac, American plum, Siberian peashrub, silver buffaloberry.	Green ash, bur oak, ponderosa pine, Russian olive.	---	---
Hecla	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
176B Velva	Amur honeysuckle, American plum, Peking cotoneaster.	Green ash, Black Hills spruce, Siberian crabapple, Siberian peashrub, common chokecherry, eastern redcedar.	Golden willow, ponderosa pine.	Plains cottonwood	---
177 LaDelle	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
180 Wyndmere	Silver buffaloberry, Siberian peashrub.	---	Russian olive, green ash.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
181 Wyndmere	---	Redosier dogwood, ponderosa pine, American plum, Amur honeysuckle, eastern redcedar, Peking cotoneaster, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
184 Wyrene	---	Amur honeysuckle, ponderosa pine, American plum, Peking cotoneaster, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
185 Karlsruhe	---	Common chokecherry, American plum, ponderosa pine, Siberian peashrub, Peking cotoneaster, eastern redcedar, Amur honeysuckle, redosier dogwood.	Black Hills spruce, green ash.	Golden willow	Eastern cottonwood.
186, 186B Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
187C*:					
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
187C*:					
Zahl	Eastern redcedar, Siberian peashrub, Amur honeysuckle.	Ponderosa pine, green ash, Russian olive, Rocky Mountain juniper.	Siberian elm	---	---
188E*:					
Zahl.					
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
188F*:					
Zahl.					
Max.					
Svea.					
189*, 189B*:					
Williams	---	Russian olive, eastern redcedar, lilac, Siberian peashrub, common chokecherry, Amur honeysuckle, American plum.	Siberian crabapple, green ash, ponderosa pine, bur oak, Black Hills spruce.	---	---
Niobell	Lilac, Siberian peashrub, golden currant, American plum.	Green ash, ponderosa pine, eastern redcedar, Rocky Mountain juniper, Russian olive, common chokecherry.	Siberian elm	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
1: Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
2: Parnell	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
5: Southam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
6: Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.
10*:				
Aberdeen	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Great Bend	Slight	Slight	Slight	Slight.
17B: Arvilla	Slight	Slight	Moderate: slope.	Slight.
18B*:				
Aylmer	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Bantry	Severe: wetness, too sandy.	Severe: too sandy.	Severe: too sandy, wetness.	Severe: too sandy.
19B*:				
Aylmer	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Minnewaukan	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
24B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Buse	Slight	Slight	Moderate: slope, small stones.	Slight.
24C*:				
Barnes	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.
24D*:				
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
24D*:				
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
24E*:				
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
29*:				
Svea	Slight	Slight	Moderate: small stones.	Slight.
Barnes	Slight	Slight	Slight	Slight.
29B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Svea	Slight	Slight	Moderate: slope, small stones.	Slight.
36*:				
Miranda	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
37*:				
Cavour	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
44B*:				
Claire	Severe: too sandy.	Severe: too sandy.	Moderate: slope.	Severe: too sandy.
Lohnes	Severe: too sandy.	Severe: too sandy.	Moderate: slope.	Severe: too sandy.
50 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
51 Colvin	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness, excess salt.	Severe: wetness.
52 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
54*:				
Barnes	Slight	Slight	Slight	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
54B*:				
Barnes	Slight	Slight	Moderate: slope.	Slight.
Cresbard	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
56 Divide	Slight	Slight	Slight	Slight.
62B Egeland	Slight	Slight	Moderate: slope.	Slight.
65 Embden	Slight	Slight	Slight	Slight.
68 Fargo	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
72 Verendrye	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.
73*:				
Fossum	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Arveson	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
74 Fossum	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
76 Gardena	Slight	Slight	Slight	Slight.
79 Glyndon	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
80 Glyndon	Slight	Slight	Slight	Slight.
82*:				
Great Bend	Slight	Slight	Slight	Slight.
Overly	Slight	Slight	Slight	Slight.
88 Hamerly	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
89 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.
90*:				
Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
90*:				
Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
91 Hecla	Slight	Slight	Slight	Slight.
104 Colvin	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.
105 Letcher	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
106*:				
Swenoda	Slight	Slight	Slight	Slight.
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
106B*:				
Swenoda	Slight	Slight	Moderate: slope.	Slight.
Larson	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
107B*:				
Lohnes	Severe: too sandy.	Severe: too sandy.	Moderate: slope.	Severe: too sandy.
Claire	Severe: too sandy.	Severe: too sandy.	Moderate: slope.	Severe: too sandy.
108*:				
Falsen	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Karlsruhe	Slight	Slight	Slight	Slight.
109D*:				
Lohnes	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
Maddock	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.
110 Ludden	Severe: flooding, ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding, flooding.	Severe: ponding, too clayey.
111 Ludden	Severe: flooding, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
112B*:				
Maddock	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
Hecla	Slight	Slight	Moderate: slope.	Slight.
124 Marysland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
127*. Pits				
136 Ryan	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium.	Severe: wetness, percs slowly.	Severe: wetness.
137 Harriet	Severe: flooding, wetness, percs slowly.	Severe: wetness, excess sodium, percs slowly.	Severe: wetness, percs slowly, excess sodium.	Severe: wetness.
139F Serden	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.
145B Sioux	Moderate: small stones.	Slight	Severe: small stones.	Slight.
145E Sioux	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.
151 Stirum	Severe: wetness, excess sodium.	Severe: excess sodium.	Severe: wetness, excess sodium.	Moderate: wetness.
157 Swenoda	Slight	Slight	Slight	Slight.
158B*:				
Swenoda	Slight	Slight	Moderate: slope.	Slight.
Barnes	Slight	Slight	Moderate: slope.	Slight.
163B Towner	Slight	Slight	Moderate: slope.	Slight.
164C*:				
Towner	Slight	Slight	Severe: slope.	Slight.
Buse	Slight	Slight	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
164C*:				
Maddock	Moderate: too sandy.	Moderate: too sandy.	Severe: slope.	Moderate: too sandy.
165E*:				
Dickey	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Maddock	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.
172 Ulen	Slight	Slight	Slight	Slight.
175*:				
Ulen	Slight	Slight	Slight	Slight.
Hecla	Slight	Slight	Slight	Slight.
176B Velva	Severe: flooding.	Slight	Moderate: slope, flooding.	Slight.
177 LaDelle	Severe: flooding.	Slight	Moderate: flooding.	Slight.
180 Wyndmere	Severe: excess salt.	Severe: excess salt.	Severe: excess salt.	Slight.
181 Wyndmere	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight.
184 Wyrene	Slight	Slight	Moderate: small stones.	Slight.
185 Karlsruhe	Slight	Slight	Slight	Slight.
186 Williams	Slight	Slight	Slight	Slight.
186B Williams	Slight	Slight	Moderate: slope.	Slight.
187C*:				
Williams	Slight	Slight	Severe: slope.	Slight.
Zahl	Slight	Slight	Severe: slope.	Slight.
188E*:				
Zahl	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Williams	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
188F*:				
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Max	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
189*:				
Williams	Slight	Slight	Slight	Slight.
Niobell	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.
189B*:				
Williams	Slight	Slight	Moderate: slope.	Slight.
Niobell	Severe: excess sodium.	Severe: excess sodium.	Severe: excess sodium.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
1: Tonka	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
2: Parnell	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
5: Southam	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
6: Rifle	Very poor	Poor	Poor	---	Good	Good	Poor	Good	---
10*:									
Aberdeen	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
Great Bend	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
17B: Arvilla	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Poor.
18B*:									
Aylmer	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Bantry	Fair	Good	Good	Fair	Fair	Very poor	Good	Poor	Fair.
19B*:									
Aylmer	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Minnewaukan	Poor	Poor	Fair	Fair	Fair	Very poor	Poor	Poor	Fair.
24B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
24C*:									
Barnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
24D*:									
Buse	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Barnes	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
24E*:									
Buse	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Barnes	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
29*:									
Svea	Good	Good	Good	Good	Poor	Poor	Good	Poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
29B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Svea	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
36*:									
Miranda	Poor	Poor	Very poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
37*:									
Cavour	Poor	Poor	Poor	Very poor	Very poor	Very poor	Poor	Very poor	Poor.
Cresbard	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
44B*:									
Claire	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
Lohnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
50 Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
51 Colvin	Poor	Fair	Poor	Fair	Good	Good	Poor	Good	Poor.
52 Colvin	Very poor	Poor	Poor	Poor	Good	Good	Poor	Good	Poor.
54*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cresbard	Good	Fair	Good	Poor	Very poor	Very poor	Good	Very poor	Good.
54B*:									
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Cresbard	Fair	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Good.
56 Divide	Fair	Fair	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
62B Egeland	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
65 Embden	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
68 Fargo	Good	Good	Fair	Poor	Poor	Good	Fair	Fair	Poor.
72 Verendrye	Poor	Fair	Fair	Fair	Fair	Very poor	Fair	Poor	Fair.
73*:									
Fossum	Poor	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
Arveson	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
74 Fossum	Fair	Fair	Poor	Poor	Good	Good	Fair	Good	Poor.
76 Gardena	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
79 Glyndon	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
80 Glyndon	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
82*:									
Great Bend	Good	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Good.
Overly	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
88 Hamerly	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair.
89 Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
90*:									
Hamerly	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Tonka	Good	Good	Fair	Poor	Good	Good	Good	Good	Poor.
91 Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
104 Colvin	Poor	Fair	Fair	Fair	Good	Good	Poor	Good	Fair.
105 Letcher	Poor	Fair	Good	Very poor	Very poor	Very poor	Poor	Very poor	Good.
106*:									
Swenoda	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
Larson	Poor	Poor	Poor	Very poor	Poor	Poor	Poor	Poor	Very poor.
106B*:									
Swenoda	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
Larson	Poor	Poor	Poor	Very poor	Poor	Very poor	Poor	Very poor	Very poor.
107B*:									
Lohnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Claire	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
108*:									
Falsen	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Poor	Fair.
Karlsruhe	Fair	Good	Good	Fair	Fair	Very poor	Good	Poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
109D*:									
Lohnes	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Maddock	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
110 Ludden	Very poor	Very poor	Very poor	Very poor	Good	Good	Very poor	Good	Very poor.
111 Ludden	Fair	Fair	Good	Good	Poor	Good	Fair	Fair	Good.
112B*:									
Maddock	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
124 Marysland	Fair	Fair	Fair	Fair	Good	Good	Fair	Good	Fair.
127*. Pits									
136 Ryan	Poor	Poor	Poor	Very poor	Good	Good	Poor	Good	Very poor.
137 Harriet	Poor	Poor	Fair	Very poor	Good	Good	Poor	Good	Poor.
139F Serden	Poor	Fair	Fair	Good	Very poor	Very poor	Fair	Very poor	Fair.
145B Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
145E Sioux	Very poor	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor	Poor.
151 Stirum	Very poor	Very poor	Very poor	Fair	Good	Fair	Very poor	Fair	Poor.
157 Swenoda	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
158B*:									
Swenoda	Fair	Fair	Good	---	Very poor	Very poor	Fair	Very poor	Good.
Barnes	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
163B Towner	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
164C*:									
Towner	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Buse	Fair	Good	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Maddock	Poor	Fair	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
165E*:									
Dickey	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
165E*:									
Buse	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Maddock	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
172 Ulen	Fair	Good	Good	---	Poor	Poor	Fair	Poor	---
175*:									
Ulen	Fair	Good	Good	---	Poor	Poor	Fair	Poor	---
Hecla	Fair	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
176B Velva	Fair	Good	Fair	Good	Poor	Very poor	Fair	Very poor	Fair.
177 LaDelle	Good	Good	Fair	Good	Very poor	Very poor	Good	Very poor	Fair.
180 Wyndmere	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
181 Wyndmere	Fair	Good	Good	Fair	Fair	Poor	Good	Poor	Fair.
184 Wyrene	Fair	Good	Good	Fair	Fair	Very poor	Fair	Poor	Fair.
185 Karlsruhe	Fair	Good	Good	Fair	Fair	Very poor	Good	Poor	Fair.
186, 186B Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
187C*:									
Williams	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Zahl	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
188E*:									
Zahl	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Williams	Fair	Good	Good	Fair	Very poor	Very poor	Good	Very poor	Fair.
188F*:									
Zahl	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Max	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Svea	Poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
189*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Niobell	Fair	Fair	Good	Poor	Poor	Poor	Fair	Poor	Fair.
189B*:									
Williams	Good	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Niobell	Fair	Fair	Good	Poor	Poor	Very poor	Fair	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1: Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
2: Parnell	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
5: Southam	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
6: Rifle	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.
10*:					
Aberdeen	Severe: cutbanks cave.	Severe: shrink-swell.	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Great Bend	Severe: cutbanks cave.	Slight	Slight	Slight	Severe: low strength, frost action.
17B: Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
18B*:					
Aylmer	Severe: cutbanks cave, wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Bantry	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness.
19B*:					
Aylmer	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Minnewaukan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
24B*, 24C*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
24B*, 24C*:					
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
24D*:					
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
Barnes	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.
24E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
29*:					
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
29B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
Svea	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Severe: low strength.
36*:					
Miranda	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength.
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
37*:					
Cavour	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
44B*:					
Claire	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Lohnes	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
50 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.
51 Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness.
52 Colvin	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.
54*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
54B*:					
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Cresbard	Moderate: too clayey, wetness.	Severe: shrink-swell.	Moderate: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
56 Divide	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.
62B Egeland	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
65 Embden	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
68 Fargo	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.
72 Verendrye	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
73*:					
Fossum	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Arveson	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.
74 Fossum	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
76 Gardena	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.
79, 80 Glyndon	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.
82*:					
Great Bend	Moderate: too clayey.	Slight	Slight	Slight	Severe: low strength, frost action.
Overly	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
88, 89 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
90*:					
Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.
Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, shrink-swell.
91 Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
104 Colvin	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.
105 Letcher	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
106*:					
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
Larson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
106B*:					
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
Larson	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
107B*:					
Lohnes	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Claire	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
108*:					
Falsen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Karlsruhe	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
109D*:					
Lohnes	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Maddock	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
110 Ludden	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.
111 Ludden	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.
112B*:					
Maddock	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
124 Marysland	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.
127*. Pits					
136 Ryan	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
137 Harriet	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, low strength.
139F Serden	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
145B Sioux	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
145E Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
151 Stirum	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
157 Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
158B*:					
Swenoda	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
Barnes	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
163B Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Slight	Moderate: frost action.
164C*:					
Towner	Severe: cutbanks cave.	Slight	Moderate: wetness, shrink-swell.	Moderate: slope.	Moderate: frost action.
Buse	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, shrink-swell.
Maddock	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
165E*:					
Dickey	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope.
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Maddock	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
172 Ulen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
175*:					
Ulen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
Hecla	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
176B Velva	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
177 LaDelle	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.
180, 181 Wyndmere	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.
184 Wyrene	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
185 Karlsruhe	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.
186 Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
186B Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
187C*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Zahl	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
188E*:					
Zahl	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Williams	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
188F*:					
Zahl	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Max	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
188F*:					
Svea	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
189*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Niobell	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, low strength.
189B*:					
Williams	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Niobell	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
2 Parnell	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
5 Southam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
6 Rifle	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
10*:					
Aberdeen	Severe: percs slowly.	Moderate: seepage.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: excess sodium.
Great Bend	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey, thin layer.
17B Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
18B*:					
Aylmer	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Bantry	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
19B*:					
Aylmer	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
Minnewaukan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
24B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24C*:					
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Buse	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24D*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Barnes	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
24E*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
29*:					
Svea	Severe: percs slowly.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
29B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Svea	Severe: percs slowly.	Moderate: slope, seepage, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
36*:					
Miranda	Severe: wetness, percs slowly.	Slight	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
37*:					
Cavour	Severe: percs slowly.	Slight	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
44B*:					
Claire	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Lohnes	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
50 Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
51 Colvin	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: wetness.
52 Colvin	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
54*:					
Barnes	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
54B*:					
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Cresbard	Severe: percs slowly.	Moderate: slope, wetness.	Severe: wetness, excess sodium.	Moderate: wetness.	Poor: hard to pack, excess sodium.
56 Divide	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
62B Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
65 Embden	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
68 Fargo	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
72 Verendrye	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
73*:					
Fossum	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Arveson	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
74 Fossum	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
76 Gardena	Moderate: wetness.	Moderate: seepage, wetness.	Severe: wetness.	Moderate: wetness.	Good.
79 Glyndon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
80 Glyndon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
82*:					
Great Bend	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey, thin layer.
Overly	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
88, 89 Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
90*:					
Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
91----- Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
104----- Colvin	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
105----- Letcher	Severe: wetness.	Severe: seepage.	Severe: seepage, excess sodium.	Severe: seepage.	Poor: excess sodium.
106*, 106B*:					
Swenoda-----	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Larson-----	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess sodium.	Severe: wetness.	Poor: excess sodium.
107B*:					
Lohnes-----	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Claire-----	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
108*:					
Falsen-----	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Karlsruhe-----	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
109D*:					
Lohnes-----	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Maddock-----	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
110----- Ludden	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, ponding.
111----- Ludden	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
112B*:					
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
124 Marysland	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
127*. Pits					
136 Ryan	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
137 Harriet	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, excess sodium.	Severe: flooding, wetness.	Poor: hard to pack, wetness, excess sodium.
139F Serden	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: too sandy, slope, seepage.
145B Sioux	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
145E Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
151 Stirum	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, excess sodium.	Severe: seepage, wetness.	Poor: wetness, excess sodium.
157 Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
158B*:					
Swenoda	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Barnes	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
163B Towner	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
164C*:					
Towner	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Moderate: wetness, too clayey.	Severe: seepage.	Fair: too clayey, wetness.
Buse	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
165E*:					
Dickey	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope, too clayey.	Severe: seepage.	Fair: too clayey, slope.
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Maddock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
172 Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
175*:					
Ulen	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Hecla	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
176B Velva	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Good.
177 LaDelle	Severe: flooding, percs slowly.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Fair: too clayey.
180, 181 Wyndmere	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
184 Wyrene	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
185 Karlsruhe	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
186 Williams	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
186B Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
187C*:					
Williams	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
188E*:					
Zahl	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Williams	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
188F*:					
Zahl	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Max	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Svea	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
189*:					
Williams	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Niobell	Severe: percs slowly.	Slight	Severe: excess sodium.	Slight	Poor: excess sodium.
189B*:					
Williams	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Niobell	Severe: percs slowly.	Moderate: slope.	Severe: excess sodium.	Slight	Poor: excess sodium.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
2 Parnell	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
5 Southam	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
6 Rifle	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
10*:				
Aberdeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
Great Bend	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
17B Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
18B*:				
Aylmer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Bantry	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
19B*:				
Aylmer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy.
Minnewaukan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, small stones, wetness.
24B*, 24C*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
24D*:				
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
24E*:				
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
29*:				
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
29B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Svea	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
36*:				
Miranda	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
37*:				
Cavour	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, excess sodium.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
44B*:				
Claire	Good	Probable	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
44B*:				
Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy, small stones.
50 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
51 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, wetness.
52 Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
54*, 54B*:				
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Cresbard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess sodium.
56 Divide	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
62B Egeland	Good	Probable	Improbable: too sandy.	Good.
65 Embden	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
68 Fargo	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, too clayey.
72 Verendrye	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
73*:				
Fossum	Fair: wetness.	Probable	Improbable: too sandy.	Poor: thin layer.
Arveson	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
74 Fossum	Poor: wetness.	Probable	Improbable: too sandy.	Poor: thin layer, wetness.
76 Gardena	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
79 Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
80-------------------- Glyndon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
82*:				
Great Bend-----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Overly---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
88-------------------- Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.
89-------------------- Hamerly	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
90*:				
Hamerly--------------	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Tonka----------------	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
91-------------------- Hecla	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
104------------------- Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
105------------------- Letcher	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
106*, 106B*:				
Swenoda--------------	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Larson---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.
107B*:				
Lohnes---------------	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy, small stones.
Claire---------------	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy.
108*:				
Falsen---------------	Fair: wetness.	Probable-------------	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
108*:				
Karlsruhe	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
109D*:				
Lohnes	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
110, 111 Ludden	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
112B*:				
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
124 Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
127*. Pits				
136 Ryan	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, excess salt, wetness.
137 Harriet	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess salt, thin layer.
139F Serden	Poor: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
145B Sioux	Good	Probable	Probable	Poor: small stones, area reclaim.
145E Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
151 Stirum	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt, excess sodium.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
157 Swenoda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
158B*:				
Swenoda	Fair: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Barnes	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
163B Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
164C*:				
Towner	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Maddock	Good	Probable	Improbable: too sandy.	Poor: too sandy.
165E*:				
Dickey	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Maddock	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
172 Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
175*:				
Ulen	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
Hecla	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
176B Velva	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
177 LaDelle	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
180 Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess salt.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
181------------------ Wyndmere	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
184------------------ Wyrene	Good----------------	Probable------------	Probable------------	Poor: small stones.
185------------------ Karlsruhe	Fair: wetness.	Probable------------	Improbable: too sandy.	Poor: too sandy.
186, 186B------------ Williams	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
187C*:				
Williams------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Zahl----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
188E*:				
Zahl----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Williams------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones, slope.
188F*:				
Zahl----------------	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Max-----------------	Fair: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Svea----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
189*, 189B*:				
Williams------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Niobell-------------	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess sodium.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
2 Parnell	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
5 Southam	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, excess salt, erodes easily.
6 Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
10*:						
Aberdeen	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium, excess salt.	Erodes easily, percs slowly.	Excess sodium, erodes easily, percs slowly.
Great Bend	Moderate: seepage.	Severe: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily.
17B Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
18B*:						
Aylmer	Severe: seepage.	Severe: seepage, piping, wetness.	Slope, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
Bantry	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
19B*:						
Aylmer	Severe: seepage.	Severe: seepage, piping, wetness.	Slope, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
Minnewaukan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
24B*, 24C*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
24B*, 24C*:						
Buse	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
24D*, 24E*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
29*:						
Svea	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
29B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Svea	Moderate: slope, seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
36*:						
Miranda	Slight	Severe: excess sodium.	Percs slowly, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Excess sodium, percs slowly.
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
37*:						
Cavour	Slight	Severe: excess sodium.	Deep to water	Percs slowly, rooting depth.	Erodes easily, percs slowly.	Excess sodium, erodes easily, rooting depth.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
44B*:						
Claire	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
50 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
51 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess salt, percs slowly.
52 Colvin	Moderate: seepage.	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
54*:						
Barnes	Slight	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
Cresbard	Slight	Severe: excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
54B*:						
Barnes	Moderate: slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Cresbard	Moderate: slope.	Severe: excess sodium.	Deep to water	Slope, percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
56 Divide	Severe: seepage.	Severe: seepage.	Cutbanks cave	Wetness	Wetness, too sandy.	Favorable.
62B Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Soil blowing, too sandy.	Droughty.
65 Embden	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing	Soil blowing	Favorable.
68 Fargo	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
72 Verendrye	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
73*:						
Fossum	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
Arveson	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
74 Fossum	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty.	Ponding, too sandy, soil blowing.	Wetness, droughty.
76 Gardena	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
79 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salt.	Wetness, excess salt.	Wetness	Excess salt.
80 Glyndon	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness	Wetness	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
82*:						
Great Bend	Moderate: seepage.	Severe: piping.	Deep to water	Percs slowly	Erodes easily	Erodes easily.
Overly	Slight	Severe: piping.	Deep to water	Percs slowly	Favorable	Percs slowly.
88 Hamerly	Slight	Severe: piping.	Frost action, excess salt.	Wetness, excess salt.	Erodes easily, wetness.	Excess salt, erodes easily.
89 Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
90*:						
Hamerly	Slight	Severe: piping.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
91 Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
104 Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
105 Letcher	Severe: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Soil blowing	Excess sodium, percs slowly.
106*:						
Swenoda	Severe: seepage.	Severe: piping.	Favorable	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
Larson	Moderate: seepage.	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable	Excess sodium, percs slowly.
106B*:						
Swenoda	Severe: seepage.	Severe: piping.	Slope	Slope, wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
Larson	Moderate: seepage, slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable	Excess sodium, percs slowly.
107B*:						
Lohnes	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Claire	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
108*:						
Falsen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
Karlsruhe	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
109D*:						
Lohnes	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
110 Ludden	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, flooding.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
111 Ludden	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
112B*:						
Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Hecla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
124 Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
127*. Pits						
136 Ryan	Slight	Severe: hard to pack, wetness, excess sodium.	Percs slowly, flooding, excess salt.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, excess sodium, percs slowly.
137 Harriet	Slight	Severe: piping, wetness, excess sodium.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, excess sodium, erodes easily.
139F Serden	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
145B Sioux	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, slope.	Too sandy	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
145E-------------- Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Droughty, slope.
151--------------- Stirum	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave, excess salt, excess sodium.	Wetness, droughty.	Wetness, too sandy.	Wetness, excess salt, excess sodium.
157--------------- Swenoda	Severe: seepage.	Severe: piping.	Favorable------	Wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
158B*:						
Swenoda----------	Severe: seepage.	Severe: piping.	Slope----------	Slope, wetness, soil blowing.	Erodes easily, wetness.	Erodes easily.
Barnes-----------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
163B-------------- Towner	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
164C*:						
Towner-----------	Severe: seepage.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Erodes easily, soil blowing.	Erodes easily, droughty.
Buse-------------	Moderate: slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Maddock----------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
165E*:						
Dickey-----------	Severe: seepage, slope.	Severe: piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, erodes easily, soil blowing.	Slope, erodes easily, droughty.
Buse-------------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Maddock----------	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
172--------------- Ulen	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
175*:						
Ulen-------------	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
Hecla------------	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
176B-------------- Velva	Severe: seepage.	Severe: piping.	Deep to water	Favorable------	Favorable------	Favorable.
177--------------- LaDelle	Slight---------	Moderate: thin layer, piping.	Deep to water	Flooding-------	Favorable------	Favorable.
180--------------- Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave, excess salt.	Wetness, soil blowing, excess salt.	Wetness, too sandy, soil blowing.	Excess salt.
181--------------- Wyndmere	Severe: seepage.	Severe: piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Favorable.
184--------------- Wyrene	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
185--------------- Karlsruhe	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
186--------------- Williams	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly---	Erodes easily	Erodes easily, percs slowly.
186B-------------- Williams	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
187C*:						
Williams---------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Zahl-------------	Moderate: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
188E*:						
Zahl-------------	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Williams---------	Severe: slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily.	Slope, erodes easily, percs slowly.
188F*:						
Zahl-------------	Severe: slope.	Moderate: piping.	Deep to water	Slope, percs slowly.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Max--------------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Svea-------------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
189*:						
Williams---------	Moderate: seepage.	Moderate: piping.	Deep to water	Percs slowly---	Erodes easily	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
189*:						
Niobell----------	Slight---------	Severe: piping, excess sodium.	Deep to water	Percs slowly, excess sodium.	Favorable------	Excess sodium, percs slowly.
189B*:						
Williams---------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Percs slowly, slope.	Erodes easily	Erodes easily, percs slowly.
Niobell----------	Moderate: slope.	Severe: piping, excess sodium.	Deep to water	Percs slowly, slope, excess sodium.	Favorable------	Excess sodium, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1---------------- Tonka	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	12-34	Silty clay loam, clay loam.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Silty clay loam, clay loam, loam.	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
2---------------- Parnell	0-13	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	13-44	Silty clay loam, silty clay.	CL, CH	A-7	0	100	95-100	90-100	70-100	40-80	20-50
	44-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	90-100	80-95	70-95	30-80	15-50
5---------------- Southam	0-3	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	90-100	85-100	25-40	5-15
	3-36	Silty clay, clay, silty clay loam.	CL, CH	A-7	0	100	95-100	90-100	85-100	40-75	15-50
	36-60	Silty clay, silty clay loam, clay loam	CL, CH, CL-ML	A-6, A-7, A-4	0	100	95-100	85-100	60-100	20-75	5-50
6---------------- Rifle	0-6	Hemic material---	PT	A-8	0	---	---	---	---	---	---
	6-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
10*:											
Aberdeen--------	0-10	Silt loam--------	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-45	7-20
	10-23	Silty clay, clay, silty clay loam.	ML, MH	A-7	0	100	100	95-100	90-100	45-75	15-40
	23-38	Silty clay loam	CL, CH, MH, ML	A-6, A-7	0	100	100	95-100	90-100	35-55	15-25
	38-60	Stratified very fine sand to clay.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
Great Bend------	0-9	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	9-14	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	14-21	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	21-39	Stratified silt loam to silty clay loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
	39-60	Stratified very fine sand to clay.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
17B-------------- Arvilla	0-7	Sandy loam-------	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	7-15	Sandy loam, loam, coarse sandy loam.	SM, SC, SM-SC	A-2, A-4, A-6	0	95-100	90-100	50-80	20-45	10-40	NP-15
	15-60	Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SP-SM, GP, SP, GP-GM	A-1, A-2, A-3	0	35-100	25-100	10-60	0-10	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
18B*:											
Aylmer----------	0-3	Fine sand--------	SM	A-2	0	100	100	65-85	15-25	---	NP
	3-60	Fine sand, sand	SM	A-2	0	100	100	65-85	15-25	---	NP
Bantry----------	0-4	Fine sand--------	SM	A-2	0	100	100	65-85	15-25	---	NP
	4-60	Fine sand, sand	SM	A-2	0	100	100	65-85	15-25	---	NP
19B*:											
Aylmer----------	0-3	Fine sand--------	SM	A-2	0	100	100	65-85	15-25	---	NP
	3-60	Fine sand, sand	SM	A-2	0	100	100	65-85	15-25	---	NP
Minnewaukan-----	0-3	Loamy fine sand	SM	A-2	0	90-100	70-100	50-85	15-30	---	NP
	3-60	Loamy coarse sand, loamy sand, fine sand.	SM, SP-SM	A-2, A-3	0	90-100	70-100	50-100	5-35	---	NP
24B*, 24C*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
24D*, 24E*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
29*:											
Svea------------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	9-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
29B*:											
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Svea------------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	9-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-85	20-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
36*:											
Miranda----------	0-3	Loam-------------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-95	60-85	25-40	5-15
	3-13	Loam, clay loam	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
	13-60	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0-5	95-100	95-100	85-95	50-80	30-50	10-20
Cavour-----------	0-10	Loam-------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	10-28	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	28-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
37*:											
Cavour-----------	0-10	Loam-------------	ML, CL, MH	A-4, A-6, A-7	0	100	95-100	85-100	60-85	30-55	5-20
	10-28	Clay, clay loam, silty clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	90-100	70-95	40-65	15-30
	28-60	Clay loam, loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-100	60-85	35-65	12-35
Cresbard---------	0-11	Loam-------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	11-18	Clay loam, silty clay, clay.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	18-36	Clay loam, silty clay, loam.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	36-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
44B*:											
Claire-----------	0-9	Coarse sand------	SP-SM, SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	9-42	Coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	42-60	Fine sand, sand, coarse sand.	SM, SP-SM	A-1, A-3, A-2-4	0	95-100	95-100	30-80	5-35	<20	NP
Lohnes-----------	0-11	Coarse sand------	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	70-100	35-60	2-20	---	NP
	11-60	Coarse sand, sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
50--------------- Colvin	0-10	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	10-38	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	38-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
51--------------- Colvin	0-10	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	20-35	10-20
	10-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	20-50	10-30
52--------------- Colvin	0-10	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	10-38	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	38-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
54*, 54B*:											
Barnes----------	0-7	Loam------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
Cresbard--------	0-11	Loam------------	ML, CL	A-4, A-6	0	100	100	85-100	60-80	30-40	5-15
	11-23	Clay loam, silty clay, loam.	CL, CH	A-7	0	100	100	90-100	70-90	40-60	15-30
	23-36	Clay loam, silty clay, loam.	CL, CH	A-7	0	100	100	85-100	70-90	40-60	15-30
	36-60	Clay loam, loam	CL, CH, ML, MH	A-6, A-7	0-5	100	100	85-100	60-80	35-55	10-27
56--------------- Divide	0-7	Loam------------	CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-85	25-40	5-20
	7-23	Loam, clay loam, gravelly loam.	CL, CL-ML	A-4, A-6	0-3	95-100	80-100	60-90	55-80	20-40	5-20
	23-60	Stratified sand to gravelly coarse sand.	GM, SM, GP-GM, SP-SM	A-1	0-5	25-75	15-65	10-40	5-25	---	NP
62B------------- Egeland	0-9	Fine sandy loam	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
	9-20	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	15-50	<30	NP-7
	20-60	Loamy sand, fine sandy loam, loam.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-100	10-45	<25	NP-5
65--------------- Embden	0-8	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-95	30-65	<35	NP-10
	8-39	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	100	60-85	30-50	---	NP
	39-60	Fine sandy loam, sandy loam, loamy fine sand.	SM	A-2, A-4	0	100	100	50-80	15-50	---	NP
68--------------- Fargo	0-7	Silty clay-------	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	7-32	Silty clay, silty clay loam, clay.	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
	32-60	Silty clay, clay	CH	A-7	0	100	100	95-100	85-100	50-75	25-50
72--------------- Verendrye	0-6	Loamy coarse sand	SM, SP-SM, SP	A-1, A-2, A-3	0	100	90-100	45-70	2-15	<25	NP
	6-10	Loamy coarse sand	SM, SP-SM, SP	A-1, A-2, A-3	0	100	90-100	45-70	2-15	<25	NP
	10-60	Coarse sand, loamy coarse sand, sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	100	90-100	45-70	2-15	<25	NP
73*:											
Fossum----------	0-13	Fine sandy loam	SM, SC, SM-SC	A-4	0	100	100	60-85	35-50	<20	NP-10
	13-17	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	17-60	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
Arveson---------	0-8	Loam------------	ML	A-4	0-1	100	95-100	85-90	50-80	20-40	NP-10
	8-35	Fine sandy loam, sandy loam, loam.	SM, SM-SC	A-4	0	100	95-100	60-85	35-50	<20	NP-5
	35-60	Fine sand, sand, fine sandy loam.	SP-SM, SM, SM-SC	A-3, A-2, A-4	0	100	95-100	50-80	5-45	<20	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
74-------------- Fossum	0-13	Fine sandy loam	SM, SC, SM-SC	A-4	0	100	100	60-85	35-50	<20	NP-10
	13-17	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	100	60-80	5-30	---	NP
	17-60	Sand, fine sand, loamy fine sand.	SP-SM, SM	A-3, A-2	0	95-100	95-100	60-80	5-20	---	NP
76-------------- Gardena	0-10	Loam------------	ML	A-4	0	100	100	75-95	60-90	25-40	NP-10
	10-60	Silt loam, very fine sandy loam, loam.	ML	A-4	0	100	100	75-95	55-90	20-40	NP-10
79-------------- Glyndon	0-12	Loam------------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-60	Silt loam, loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
80-------------- Glyndon	0-12	Loam------------	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	12-60	Silt loam, loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
82*:											
Great Bend------	0-9	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-50	10-25
	9-14	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	14-39	Silt loam, silty clay loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	39-60	Stratified silty clay loam to silty clay.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-25
Overly---------	0-6	Loam------------	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	85-100	25-45	5-25
	6-25	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
	25-60	Stratified silt loam to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	90-100	80-100	25-50	5-30
88-------------- Hamerly	0-6	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	25-40	5-20
	6-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	25-45	5-20
89-------------- Hamerly	0-6	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	6-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25
90*:											
Hamerly---------	0-6	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-20
	6-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	32-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	75-95	60-75	20-45	5-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
90*:											
Tonka----------	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-35	5-15
	12-34	Silty clay loam, clay loam.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	34-60	Clay loam, loam	CL, CL-ML	A-6, A-7, A-4	0-3	90-100	85-100	75-100	55-90	25-50	5-30
91-------------- Hecla	0-5	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	5-30	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	30-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
104------------- Colvin	0-10	Silt loam--------	CL	A-6	0	100	100	90-100	80-95	25-40	10-20
	10-38	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	38-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
105------------- Letcher	0-8	Fine sandy loam	SM, SM-SC	A-4	0	100	100	60-95	35-50	<30	NP-7
	8-12	Sandy loam, fine sandy loam, loamy fine sand.	SM, SM-SC	A-2, A-4	0	100	100	60-95	20-45	<30	NP-7
	12-44	Loam, sandy loam, fine sandy loam.	SM, SC, ML, CL	A-4, A-6, A-2	0	100	100	60-95	30-60	25-40	3-18
	44-60	Loamy fine sand, fine sandy loam, sandy loam.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	95-100	50-95	30-60	25-40	3-18
106*, 106B*:											
Swenoda---------	0-11	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	11-32	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	32-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-20
Larson----------	0-12	Fine sandy loam	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	75-100	50-90	15-40	5-20
	12-27	Loamy fine sand, clay loam, loam.	CL	A-6, A-7	0-5	95-100	85-100	75-100	60-80	30-45	10-25
	27-60	Loam, clay loam.	CL, CL-ML	A-6, A-4, A-7	0-5	95-100	85-100	75-100	60-90	15-45	5-25
107B*:											
Lohnes----------	0-11	Coarse sand------	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	70-100	35-60	2-20	---	NP
	11-60	Coarse sand, sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
Claire----------	0-9	Coarse sand------	SP-SM, SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	9-42	Coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	95-100	30-75	5-15	<20	NP
	42-60	Fine sand, sand, coarse sand.	SM, SP-SM	A-1, A-3, A-2-4	0	95-100	95-100	30-80	5-35	<20	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
108*:											
Falsen----------	0-12	Coarse sand------	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	65-80	2-20	---	NP
	12-60	Coarse sand, sand	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	65-80	2-20	---	NP
Karlsruhe-------	0-11	Sandy loam-------	SM, SC, SM-SC	A-2, A-4, A-6	0	100	100	60-75	30-40	<35	NP-15
	11-15	Coarse sandy loam, loamy coarse sand, loamy sand.	SM, SC, SM-SC, SM	A-1, A-2, A-4, A-6	0	100	100	45-75	10-40	<35	NP-15
	15-60	Loamy coarse sand, coarse sand, sand.	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	65-80	2-20	---	NP
109D*:											
Lohnes----------	0-11	Coarse sand------	SM, SP-SM	A-2, A-1	0	100	100	45-65	10-25	---	NP
	11-60	Coarse sand, sand.	SM, SP-SM, SP	A-2, A-1, A-3	0	80-100	65-100	35-60	2-20	---	NP
Maddock---------	0-15	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	15-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
110, 111--------- Ludden	0-5	Clay-------------	CH	A-7	0	100	100	95-100	75-95	50-75	25-50
	5-17	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	75-95	50-75	25-50
	17-60	Silty clay, clay, clay loam.	CH	A-7	0	100	100	95-100	75-95	50-75	25-50
112B*:											
Maddock---------	0-15	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	15-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
Hecla-----------	0-5	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	5-30	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	30-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
124-------------- Marysland	0-9	Silt loam--------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	9-35	Loam, silt loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	35-60	Stratified sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP
127*. Pits											
136-------------- Ryan	0-1	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	60-80	25-40	5-15
	1-60	Silty clay, silty clay loam, clay.	CH	A-7	0	100	100	90-100	75-95	50-75	25-50

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
137-------------- Harriet	0-1	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-90	25-40	5-20
	1-23	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-100	35-70	20-40
	23-60	Stratified loamy fine sand to silty clay.	CL, CL-ML, CH	A-4, A-6, A-7	0	100	100	90-100	60-100	20-65	5-40
139F------------- Serden	0-2	Sand-------------	SM	A-2	0	100	100	65-85	15-25	---	NP
	2-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	65-85	5-25	---	NP
145B, 145E------- Sioux	0-5	Gravelly sandy loam.	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	5-7	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	7-60	Extremely gravelly sand, very gravelly loamy sand, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	20-60	5-35	0-25	<25	NP-5
151-------------- Stirum	0-5	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-4	0	100	100	70-95	40-75	15-25	NP-5
	5-38	Loam, fine sandy loam, very fine sandy loam.	SC, CL, ML, SM	A-2, A-4	0	100	100	60-95	30-75	15-30	NP-10
	38-60	Stratified loam to loamy fine sand.	SM, CL, ML, SC	A-2, A-4	0	100	100	50-100	15-90	<30	NP-10
157-------------- Swenoda	0-14	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	14-30	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	30-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-20
158B*:											
Swenoda---------	0-11	Fine sandy loam	SM	A-2, A-4	0	100	95-100	70-100	30-50	20-30	NP-7
	11-32	Fine sandy loam, sandy loam.	SM-SC, SM, ML, CL-ML	A-2, A-4	0	100	95-100	60-85	30-55	20-30	NP-10
	32-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	95-100	75-100	50-95	25-45	5-20
Barnes----------	0-7	Loam-------------	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	80-100	60-90	20-40	5-20
	7-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
	18-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-95	55-80	25-40	5-20
163B------------- Towner	0-19	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	19-27	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC, SW-SM	A-2, A-3	0	100	95-100	50-80	5-35	<25	NP-5
	27-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-95	55-80	25-50	5-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
164C*:											
Towner----------	0-19	Loamy fine sand	SM, SM-SC	A-2	0	100	100	50-80	15-35	<25	NP-5
	19-27	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC, SW-SM	A-2, A-3	0	100	95-100	50-80	5-35	<25	NP-5
	27-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	85-95	55-80	25-50	5-30
Buse------------	0-7	Loam------------	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Maddock---------	0-15	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	15-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
165E*:											
Dickey----------	0-5	Loamy fine sand	SM	A-2-4	0	100	100	50-75	15-30	---	NP
	5-26	Loamy fine sand, loamy sand, fine sand.	SM	A-2-4	0	100	100	50-80	15-35	---	NP
	26-60	Loam, clay loam, silty clay loam.	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	85-100	60-90	24-40	4-20
Buse------------	0-7	Loam------------	ML, CL, CL-ML	A-4, A-6, A-7	0	90-100	85-95	70-95	55-90	20-45	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-100	70-90	60-85	25-40	5-20
Maddock---------	0-15	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	15-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	60-100	5-35	---	NP
172-------------- Ulen	0-7	Fine sandy loam	SM, SM-SC, SC	A-4	0	100	100	80-100	35-50	<25	NP-8
	7-34	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	34-60	Fine sand--------	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP
175*:											
Ulen------------	0-15	Loamy fine sand	SM	A-4, A-2	0	100	100	80-100	20-50	<20	NP-4
	15-42	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	70-95	12-35	---	NP
	42-60	Fine sand--------	SP-SM, SM	A-3, A-2	0	100	95-100	80-100	5-35	---	NP
Hecla-----------	0-5	Loamy fine sand	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	5-30	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	12-35	15-30	NP-7
	30-60	Loamy sand, fine sand, loamy fine sand.	SM, SM-SC	A-2	0	100	95-100	85-100	10-35	15-30	NP-7
176B------------- Velva	0-5	Loam------------	ML, CL, CL-ML	A-4, A-6	0	100	100	85-95	60-75	20-35	3-15
	5-60	Fine sandy loam, silty clay loam, loam.	ML, SM	A-4	0	100	100	70-95	40-75	20-30	NP-5

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
177-------------- LaDelle	0-20	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	20-44	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	44-60	Silty clay loam, silt loam, loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	100	90-100	75-100	30-50	5-25
180-------------- Wyndmere	0-8	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	8-24	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	24-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
181-------------- Wyndmere	0-9	Fine sandy loam	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	9-39	Sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-80	30-55	---	NP
	39-60	Fine sand, loamy fine sand, fine sandy loam.	SM, ML	A-2, A-4	0	100	100	60-85	20-55	---	NP
184-------------- Wyrene	0-28	Sandy loam-------	SM-SC, ML, SM, SC	A-2, A-4	0	95-100	85-100	60-90	30-65	10-30	NP-10
	28-60	Coarse sand, sand, gravelly coarse sand.	SM, SP-SM	A-1, A-2, A-3	0-5	60-90	55-80	30-70	5-15	<20	NP
185-------------- Karlsruhe	0-11	Coarse sandy loam	SM, SC, SM-SC	A-2, A-4, A-6	0	100	100	60-75	30-40	<35	NP-15
	11-20	Coarse sandy loam, loamy coarse sand, loamy sand.	SM, SC, SM-SC, SM	A-1, A-2, A-4, A-6	0	100	100	45-75	10-40	<35	NP-15
	20-60	Loamy coarse sand, coarse sand, sand.	SM, SP-SM, SP	A-2, A-3	0	95-100	90-100	65-80	2-20	---	NP
186, 186B-------- Williams	0-5	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	5-18	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	18-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
187C*:											
Williams--------	0-5	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	5-18	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	18-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam-------------	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
188E*:											
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam-------------	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Williams--------	0-5	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	5-18	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	18-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
188F*:											
Zahl------------	0-5	Loam-------------	CL	A-6	0-1	95-100	95-100	80-95	55-75	25-40	10-20
	5-20	Loam-------------	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
	20-60	Clay loam, loam	CL	A-6	0-1	95-100	90-100	80-95	60-80	25-40	10-20
Max--------------	0-6	Loam-------------	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-95	60-75	25-45	3-23
	6-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6, A-7	0-3	95-100	95-100	85-100	60-80	25-45	3-23
Svea------------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	85-100	80-95	60-90	20-40	5-25
	9-32	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-45	5-25
	32-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	85-100	80-95	60-90	20-50	5-30
189*, 189B*:											
Williams--------	0-5	Loam-------------	CL, ML	A-4, A-6, A-7	0-5	95-100	95-100	85-95	60-90	25-45	3-20
	5-18	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
	18-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-100	60-80	30-50	10-30
Niobell---------	0-14	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	85-95	60-75	25-40	3-18
	14-31	Clay loam, loam	CL, CH	A-6, A-7	0-1	95-100	95-100	90-100	70-80	30-60	15-35
	31-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-1	95-100	95-100	85-95	60-75	25-40	3-18

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
1-----------------	0-12	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low--------	0.32	5	6
Tonka	12-34	0.06-0.2	0.14-0.19	5.6-8.4	<2	High-------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
2-----------------	0-13	0.2-0.6	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7
Parnell	13-44	0.06-0.2	0.13-0.19	6.1-7.8	<2	High-------	0.28		
	44-60	0.06-0.2	0.11-0.19	6.6-8.4	<2	High-------	0.28		
5-----------------	0-3	0.2-0.6	0.22-0.24	6.6-8.4	2-8	Moderate	0.37	5	6
Southam	3-36	0.06-0.2	0.14-0.20	6.6-8.4	2-8	High-------	0.28		
	36-60	0.06-0.6	0.13-0.17	7.4-9.0	2-8	High-------	0.28		
6-----------------	0-6	0.6-6.0	0.45-0.55	5.6-7.8	<2	-----------	----	2	5
Rifle	6-60	0.6-6.0	0.45-0.55	5.6-7.8	<2	-----------	----		
10*:									
Aberdeen---------	0-10	0.6-2.0	0.19-0.22	5.6-7.8	<2	Moderate	0.32	3	6
	10-23	0.06-0.2	0.13-0.18	6.6-8.4	<4	High-------	0.32		
	23-38	0.06-0.2	0.14-0.17	7.4-9.0	2-8	High-------	0.43		
	38-60	0.06-2.0	0.14-0.17	7.4-9.0	2-8	Low--------	0.43		
Great Bend-------	0-9	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate	0.32	5	7
	9-14	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.43		
	14-21	0.6-2.0	0.17-0.20	7.4-9.0	<2	Low--------	0.43		
	21-39	0.2-0.6	0.17-0.20	7.4-9.0	<4	Low--------	0.43		
	39-60	0.06-2.0	0.17-0.20	7.4-9.0	<8	Low--------	0.43		
17B---------------	0-7	2.0-6.0	0.13-0.15	6.6-8.4	<2	Low--------	0.20	3	3
Arvilla	7-15	2.0-6.0	0.11-0.14	6.6-8.4	<2	Low--------	0.20		
	15-60	>20	0.02-0.05	7.4-8.4	<2	Low--------	0.10		
18B*:									
Aylmer-----------	0-3	6.0-20	0.06-0.12	6.6-7.3	<2	Low--------	0.15	5	1
	3-60	6.0-20	0.05-0.07	6.1-8.4	<2	Low--------	0.15		
Bantry-----------	0-4	6.0-20	0.06-0.12	6.1-7.8	<2	Low--------	0.15	5	1
	4-60	6.0-20	0.05-0.07	6.1-8.4	<2	Low--------	0.15		
19B*:									
Aylmer-----------	0-3	6.0-20	0.06-0.12	6.6-7.3	<2	Low--------	0.15	5	1
	3-60	6.0-20	0.05-0.07	6.1-8.4	<2	Low--------	0.15		
Minnewaukan------	0-3	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.17	5	2
	3-60	6.0-20	0.05-0.10	7.4-8.4	2-4	Low--------	0.15		
24B*, 24C*:									
Barnes-----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
24D*, 24E*:									
Buse-------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
24D*, 24E*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low--------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
29*:									
Svea------------	0-9	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	9-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
29B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
Svea------------	0-9	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	9-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
36*:									
Miranda---------	0-3	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low-------	0.32	3	6
	3-13	<0.06	0.14-0.18	6.6-8.4	2-8	Moderate	0.32		
	13-60	<0.06	0.13-0.17	7.9-9.0	4-16	Moderate	0.32		
Cavour----------	0-10	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	10-28	<0.06	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	28-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
37*:									
Cavour----------	0-10	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.37	3	6
	10-28	<0.06	0.10-0.16	6.6-9.0	4-16	High------	0.37		
	28-60	0.06-0.6	0.11-0.15	7.4-9.0	8-16	Moderate	0.37		
Cresbard--------	0-11	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	11-18	0.06-0.6	0.11-0.14	5.6-7.3	2-4	High------	0.32		
	18-36	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	36-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
44B*:									
Claire----------	0-9	6.0-20	0.06-0.10	6.1-7.3	<2	Low-------	0.15	5	2
	9-42	6.0-20	0.03-0.06	6.6-8.4	<2	Low-------	0.15		
	42-60	6.0-20	0.02-0.09	7.4-8.4	<2	Low-------	0.15		
Lohnes----------	0-11	6.0-20	0.06-0.08	6.6-7.8	<2	Low-------	0.15	5	1
	11-60	6.0-20	0.03-0.07	6.6-8.4	<2	Low-------	0.15		
50--------------- Colvin	0-10	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	10-38	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	38-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		
51--------------- Colvin	0-10	0.6-2.0	0.15-0.17	7.4-9.0	4-16	Moderate	0.32	5	4L
	10-60	0.2-0.6	0.11-0.15	7.4-9.0	4-16	Moderate	0.32		
52--------------- Colvin	0-10	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	10-38	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	38-60	0.2-0.6	0.15-0.20	7.4-9.0	<2	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
54*, 54B*:									
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-40	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
	40-60	0.2-0.6	0.14-0.19	7.4-8.4	<8	Moderate	0.37		
Cresbard--------	0-11	0.6-2.0	0.17-0.20	5.6-7.3	<2	Low-------	0.32	3	6
	11-23	0.06-0.6	0.11-0.14	5.6-8.4	2-4	High------	0.32		
	23-36	0.06-0.2	0.11-0.15	6.1-8.4	2-4	High------	0.32		
	36-60	0.2-0.6	0.16-0.20	7.4-9.0	2-8	Moderate	0.32		
56--------------- Divide	0-7	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low-------	0.28	4	4L
	7-23	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low-------	0.28		
	23-60	>20	0.03-0.07	7.4-8.4	<2	Low-------	0.10		
62B-------------- Egeland	0-9	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low-------	0.20	5	3
	9-20	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low-------	0.20		
	20-60	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low-------	0.20		
65--------------- Embden	0-8	2.0-6.0	0.13-0.18	6.6-7.3	<2	Low-------	0.20	5	3
	8-39	2.0-6.0	0.12-0.17	6.6-7.8	<2	Low-------	0.20		
	39-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low-------	0.20		
68--------------- Fargo	0-7	0.06-0.2	0.15-0.18	6.6-7.8	<2	High------	0.32	5	4
	7-32	0.06-0.2	0.14-0.17	6.6-7.8	<2	High------	0.32		
	32-60	0.06-0.2	0.14-0.17	7.9-8.4	<2	High------	0.32		
72--------------- Verendrye	0-6	6.0-20	0.04-0.10	6.6-8.4	<2	Low-------	0.15	5	2
	6-10	6.0-20	0.04-0.10	7.4-8.4	<2	Low-------	0.15		
	10-60	6.0-20	0.02-0.07	7.4-8.4	<2	Low-------	0.15		
73*:									
Fossum----------	0-13	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low-------	0.20	5	3
	13-17	6.0-20	0.06-0.11	7.4-8.4	<2	Low-------	0.17		
	17-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low-------	0.17		
Arveson---------	0-8	2.0-6.0	0.16-0.18	7.4-8.4	<2	Low-------	0.24	4	4L
	8-35	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low-------	0.24		
	35-60	2.0-20	0.05-0.15	7.4-8.4	<2	Low-------	0.17		
74--------------- Fossum	0-13	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low-------	0.20	5	3
	13-17	6.0-20	0.06-0.11	7.4-8.4	<2	Low-------	0.17		
	17-60	6.0-20	0.05-0.09	7.4-8.4	<2	Low-------	0.17		
76--------------- Gardena	0-10	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low-------	0.28	5	5
	10-60	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low-------	0.43		
79--------------- Glyndon	0-12	0.6-2.0	0.13-0.15	7.4-9.0	4-16	Low-------	0.28	4	4L
	12-60	0.6-2.0	0.11-0.13	7.9-9.0	4-16	Low-------	0.28		
80--------------- Glyndon	0-12	0.6-2.0	0.20-0.23	7.4-9.0	<4	Low-------	0.28	4	4L
	12-60	0.6-2.0	0.17-0.20	7.4-9.0	<4	Low-------	0.28		
82*:									
Great Bend------	0-9	0.6-2.0	0.19-0.22	6.1-7.8	<2	Moderate	0.32	5	7
	9-14	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.43		
	14-39	0.6-2.0	0.17-0.20	7.4-9.0	<2	Low-------	0.43		
	39-60	0.2-0.6	0.17-0.20	7.4-9.0	<4	Low-------	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
82*:									
Overly----------	0-6	0.2-0.6	0.22-0.24	6.6-7.8	<2	Moderate	0.32	5	6
	6-25	0.2-0.6	0.17-0.22	6.6-8.4	<2	Moderate	0.32		
	25-60	0.06-0.6	0.13-0.22	7.9-8.4	<2	Moderate	0.32		
88-------------- Hamerly	0-6	0.6-2.0	0.12-0.15	7.4-8.4	4-16	Moderate	0.28	5	4L
	6-32	0.6-2.0	0.10-0.13	7.4-8.4	4-16	Moderate	0.28		
	32-60	0.2-0.6	0.10-0.13	7.4-8.4	4-16	Moderate	0.37		
89-------------- Hamerly	0-6	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	6-32	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
90*:									
Hamerly---------	0-6	0.6-2.0	0.18-0.24	6.6-8.4	<2	Moderate	0.28	5	4L
	6-32	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Tonka-----------	0-12	0.6-2.0	0.18-0.23	5.6-7.8	<2	Low-------	0.32	5	6
	12-34	0.06-0.2	0.14-0.19	5.6-8.4	<2	High------	0.43		
	34-60	0.2-0.6	0.14-0.19	6.6-9.0	<2	Moderate	0.43		
91-------------- Hecla	0-5	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	5-30	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	30-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low-------	0.17		
104------------- Colvin	0-10	0.6-2.0	0.20-0.22	7.4-9.0	<2	Moderate	0.32	5	4L
	10-38	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
	38-60	0.2-0.6	0.16-0.20	7.4-9.0	<2	Moderate	0.32		
105------------- Letcher	0-8	0.6-2.0	0.11-0.17	5.1-7.8	<2	Low-------	0.24	3	3
	8-12	0.6-6.0	0.10-0.15	5.1-9.0	<2	Low-------	0.24		
	12-44	0.06-0.2	0.08-0.14	6.6-9.0	2-8	Low-------	0.24		
	44-60	2.0-6.0	0.11-0.18	7.4-9.0	2-8	Low-------	0.24		
106*, 106B*:									
Swenoda---------	0-11	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	11-32	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	32-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
Larson----------	0-12	0.6-2.0	0.16-0.24	6.1-7.3	<2	Moderate	0.32	3	5
	12-27	0.06-0.2	0.10-0.14	7.4-9.0	4-16	Moderate	0.32		
	27-60	0.2-2.0	0.12-0.16	7.9-9.0	2-8	Moderate	0.32		
107B*:									
Lohnes----------	0-11	6.0-20	0.06-0.08	6.6-7.8	<2	Low-------	0.15	5	1
	11-60	6.0-20	0.03-0.07	6.6-8.4	<2	Low-------	0.15		
Claire----------	0-9	6.0-20	0.06-0.10	6.1-7.3	<2	Low-------	0.15	5	2
	9-42	6.0-20	0.03-0.06	6.6-8.4	<2	Low-------	0.15		
	42-60	6.0-20	0.02-0.09	7.4-8.4	<2	Low-------	0.15		
108*:									
Falsen----------	0-12	6.0-20	0.04-0.09	6.6-7.8	<2	Low-------	0.15	5	1
	12-60	6.0-20	0.03-0.07	6.6-8.4	<2	Low-------	0.15		
Karlsruhe-------	0-11	2.0-20	0.10-0.13	6.6-8.4	<2	Low-------	0.24	5	3
	11-15	2.0-20	0.08-0.13	7.4-8.4	<2	Low-------	0.15		
	15-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low-------	0.15		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
109D*:									
Lohnes----------	0-11	6.0-20	0.08-0.10	6.6-7.8	<2	Low-------	0.15	5	2
	11-60	6.0-20	0.03-0.07	6.6-8.4	<2	Low-------	0.15		
Maddock---------	0-15	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	15-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
110, 111--------- Ludden	0-5	0.06-0.2	0.16-0.18	6.1-8.4	<4	High------	0.28	5	4
	5-17	0.06-0.2	0.13-0.16	7.9-8.4	<4	High------	0.28		
	17-60	0.06-0.2	0.13-0.16	7.9-8.4	<8	High------	0.28		
112B*:									
Maddock---------	0-15	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	15-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low-------	0.17		
Hecla-----------	0-5	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17	5	2
	5-30	2.0-20	0.10-0.12	6.1-7.8	<2	Low-------	0.17		
	30-60	6.0-20	0.06-0.10	6.1-8.4	<2	Low-------	0.17		
124------------- Marysland	0-9	0.6-2.0	0.17-0.22	7.9-8.4	<2	Moderate	0.28	4	4L
	9-35	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28		
	35-60	>6.0	0.02-0.07	7.9-8.4	<2	Low-------	0.15		
127*. Pits									
136------------- Ryan	0-1	0.6-2.0	0.17-0.20	6.6-8.4	<2	Low-------	0.28	3	6
	1-60	<0.06	0.10-0.14	7.4-9.0	4-16	High------	0.28		
137------------- Harriet	0-1	0.06-0.2	0.20-0.24	6.6-8.4	<2	Moderate	0.37	3	6
	1-23	<0.06	0.10-0.15	>7.3	4-16	High------	0.37		
	23-60	0.06-0.2	0.10-0.15	>7.8	4-16	Moderate	0.37		
139F------------ Serden	0-2	6.0-20	0.06-0.12	6.1-7.3	<2	Low-------	0.15	5	1
	2-60	6.0-20	0.05-0.07	6.6-7.8	<2	Low-------	0.15		
145B, 145E------- Sioux	0-5	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low-------	0.20	2	8
	5-7	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low-------	0.20		
	7-60	>20	0.03-0.06	7.4-8.4	<2	Low-------	0.10		
151------------- Stirum	0-5	0.6-2.0	0.13-0.18	7.4-8.4	2-8	Low-------	0.24	3	4L
	5-38	0.2-0.6	0.12-0.18	>7.8	2-16	Low-------	0.32		
	38-60	2.0-6.0	0.06-0.18	>7.8	2-16	Low-------	0.17		
157------------- Swenoda	0-14	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	14-30	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	30-60	0.2-0.6	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
158B*:									
Swenoda---------	0-11	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low-------	0.20	5	3
	11-32	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low-------	0.20		
	32-60	0.2-2.0	0.17-0.20	7.4-8.4	<4	Moderate	0.37		
Barnes----------	0-7	0.6-2.0	0.13-0.24	5.6-7.8	<2	Low-------	0.28	5	6
	7-18	0.6-2.0	0.15-0.19	6.1-7.8	<4	Moderate	0.28		
	18-60	0.2-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37		
163B------------ Towner	0-19	6.0-20	0.08-0.12	6.6-7.8	<2	Low-------	0.17	5	2
	19-27	6.0-20	0.06-0.13	6.6-7.8	<2	Low-------	0.17		
	27-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH	mmhos/cm				
164C*:									
Towner----------	0-19	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	19-27	6.0-20	0.06-0.13	6.6-7.8	<2	Low--------	0.17		
	27-60	0.2-0.6	0.14-0.22	7.4-8.4	<2	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Maddock---------	0-15	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	15-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
165E*:									
Dickey----------	0-5	6.0-20	0.08-0.12	6.1-7.8	<2	Low--------	0.17	5	2
	5-26	6.0-20	0.06-0.12	6.1-7.8	<2	Low--------	0.17		
	26-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Buse------------	0-7	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	7-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Maddock---------	0-15	6.0-20	0.08-0.12	6.6-7.8	<2	Low--------	0.17	5	2
	15-60	6.0-20	0.05-0.13	6.6-8.4	<2	Low--------	0.17		
172-------------- Ulen	0-7	2.0-6.0	0.13-0.18	7.4-8.4	<4	Low--------	0.17	4	3
	7-34	6.0-20	0.06-0.10	7.9-8.4	<4	Low--------	0.17		
	34-60	6.0-20	0.06-0.08	7.4-8.4	<4	Low--------	0.17		
175*:									
Ulen------------	0-15	6.0-20	0.10-0.13	7.4-8.4	<4	Low--------	0.17	4	2
	15-42	6.0-20	0.06-0.10	7.9-8.4	<4	Low--------	0.17		
	42-60	6.0-20	0.06-0.08	7.4-8.4	<4	Low--------	0.17		
Hecla-----------	0-5	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2
	5-30	2.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17		
	30-60	2.0-20	0.06-0.10	6.1-8.4	<2	Low--------	0.17		
176B------------- Velva	0-5	0.6-2.0	0.20-0.22	6.6-7.8	<2	Low--------	0.20	5	5
	5-60	0.6-6.0	0.16-0.22	6.6-8.4	<2	Low--------	0.20		
177-------------- LaDelle	0-20	0.2-0.6	0.18-0.22	6.6-7.8	<2	Moderate	0.28	5	7
	20-44	0.2-0.6	0.16-0.20	7.4-8.4	<4	Moderate	0.28		
	44-60	0.2-0.6	0.16-0.20	7.4-8.4	<4	Moderate	0.28		
180-------------- Wyndmere	0-8	2.0-6.0	0.13-0.18	7.4-8.4	4-16	Low--------	0.20	5	3
	8-24	2.0-6.0	0.12-0.17	7.4-8.4	4-16	Low--------	0.20		
	24-60	2.0-6.0	0.06-0.16	7.4-8.4	4-8	Low--------	0.20		
181-------------- Wyndmere	0-9	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low--------	0.20	5	3
	9-39	2.0-6.0	0.12-0.17	7.4-8.4	<2	Low--------	0.20		
	39-60	2.0-6.0	0.06-0.16	7.4-8.4	<2	Low--------	0.20		
184-------------- Wyrene	0-28	2.0-6.0	0.12-0.20	6.6-8.4	<2	Low--------	0.20	3	3
	28-60	6.0-20	0.02-0.07	7.4-8.4	<2	Low--------	0.15		
185-------------- Karlsruhe	0-11	2.0-20	0.10-0.13	6.6-8.4	<2	Low--------	0.24	5	3
	11-20	2.0-20	0.08-0.13	7.4-8.4	<2	Low--------	0.15		
	20-60	6.0-20	0.03-0.07	7.4-8.4	<2	Low--------	0.15		
186, 186B-------- Williams	0-5	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low--------	0.28	5	6
	5-18	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	18-60	0.2-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group
							K	T	
	In	In/hr	In/in	pH	mmhos/cm				
187C*:									
Williams--------	0-5	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	5-18	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	18-60	0.2-0.6	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
188E*:									
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
Williams--------	0-5	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	5-18	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	18-60	0.06-0.2	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
188F*:									
Zahl------------	0-5	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L
	5-20	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
	20-60	0.2-0.6	0.15-0.19	7.4-8.4	<2	Moderate	0.37		
Max-------------	0-6	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate	0.28	5	6
	6-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
Svea------------	0-9	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.28	5	6
	9-32	0.6-2.0	0.17-0.22	6.6-7.8	<2	Moderate	0.28		
	32-60	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37		
189*, 189B*:									
Williams--------	0-5	0.6-2.0	0.17-0.24	6.6-7.3	<2	Low-------	0.28	5	6
	5-18	0.6-2.0	0.16-0.20	6.6-7.8	<2	Moderate	0.28		
	18-60	0.06-0.2	0.15-0.18	7.9-8.4	<2	Moderate	0.37		
Niobell---------	0-14	0.6-2.0	0.20-0.22	5.6-7.3	<2	Moderate	0.32	3	6
	14-31	0.06-0.2	0.15-0.19	6.1-8.4	<2	High------	0.32		
	31-60	0.2-0.6	0.15-0.19	7.9-9.0	2-8	Moderate	0.32		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1: Tonka	C/D	None	---	---	+.5-1.0	Apparent	Apr-Jun	High	High	Low.
2: Parnell	C/D	None	---	---	+2-2.0	Apparent	Jan-Dec	High	High	Low.
5: Southam	D	None	---	---	+5-1.0	Apparent	Jan-Dec	High	High	Low.
6: Rifle	A/D	None	---	---	+1-1.0	Apparent	Nov-Jun	High	High	Low.
10*:										
Aberdeen	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Great Bend	B	None	---	---	>6.0	---	---	High	High	Moderate.
17B: Arvilla	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
18B*:										
Aylmer	A	None	---	---	1.5-3.5	Apparent	Apr-Jun	Low	Moderate	Low.
Bantry	A/D	None	---	---	1.0-2.0	Apparent	Apr-Jun	Low	Moderate	Low.
19B*:										
Aylmer	A	None	---	---	1.5-3.5	Apparent	Apr-Jun	Low	Moderate	Low.
Minnewaukan	A/D	None	---	---	0-2.5	Apparent	Apr-Jun	Moderate	High	Low.
24B*, 24C*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
24D*, 24E*:										
Buse	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
29*:										
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
29B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Svea	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
36*:										
Miranda	D	None	---	---	2.0-4.0	Apparent	Apr-Jul	Moderate	High	Moderate.
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
37*:										
Cavour	D	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
44B*:										
Claire	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
Lohnes	A	None	---	---	>6.0	---	---	Low	Moderate	Low.
50 Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	High	High	Low.
51 Colvin	C	None	---	---	0-2.0	Apparent	Apr-Jul	High	High	Moderate.
52 Colvin	C/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
54*, 54B*:										
Barnes	B	None	---	---	>6.0	---	---	Moderate	High	Low.
Cresbard	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Moderate.
56 Divide	B	None	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High	Low.
62B Egeland	B	None	---	---	>6.0	---	---	Low	Moderate	Low.
65 Embden	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	Moderate	High	Low.
68 Fargo	D	None	---	---	0-3.0	Apparent	Sep-Jun	High	High	Low.
72 Verendrye	B/D	None	---	---	1.0-2.5	Apparent	Sep-Jul	Moderate	High	Low.
73*:										
Fossum	A/D	None	---	---	1.0-2.5	Apparent	Nov-Oct	Moderate	High	Low.
Arveson	B/D	None	---	---	1.0-2.0	Apparent	Apr-Jul	High	High	Low.
74 Fossum	A/D	None	---	---	+1-1.0	Apparent	Jan-Nov	Moderate	High	Low.
76 Gardena	B	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	Moderate	Low.
79 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Moderate.
80 Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	High	High	Low.
82*:										
Great Bend	B	None	---	---	>6.0	---	---	High	High	Moderate.
Overly	C	None	---	---	4.0-6.0	Apparent	Apr-Jun	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
88-----Hamerly	C	None-----	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
89-----Hamerly	C	None-----	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
90*:										
Hamerly-----	C	None-----	---	---	2.0-4.0	Apparent	Apr-Jun	High-----	High-----	Low.
Tonka-----	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	High-----	High-----	Low.
91-----Hecla	A	None-----	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
104-----Colvin	C/D	Frequent-----	Brief-----	Mar-Jul	0-1.0	Apparent	Apr-Jul	High-----	High-----	Low.
105-----Letcher	D	None-----	---	---	3.5-6.0	Perched	Nov-Jun	Moderate	High-----	Moderate.
106*, 106B*:										
Swenoda-----	B	None-----	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High-----	Moderate.
Larson-----	D	None-----	---	---	3.0-6.0	Apparent	Mar-Jun	Moderate	High-----	Moderate.
107B*:										
Lohnes-----	A	None-----	---	---	>6.0	---	---	Low-----	Moderate	Low.
Claire-----	A	None-----	---	---	>6.0	---	---	Low-----	Moderate	Low.
108*:										
Falsen-----	A	None-----	---	---	2.5-4.0	Apparent	Apr-Jun	Moderate	Moderate	Low.
Karlsruhe-----	B	None-----	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High-----	Low.
109D*:										
Lohnes-----	A	None-----	---	---	>6.0	---	---	Low-----	Moderate	Low.
Maddock-----	A	None-----	---	---	>6.0	---	---	Low-----	Moderate	Low.
110-----Ludden	D	Frequent-----	Brief to long.	Mar-Jun	+2-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
111-----Ludden	D	Occasional	Brief to long.	Mar-Jun	0-2.0	Apparent	Mar-Jun	High-----	High-----	Low.
112B*:										
Maddock-----	A	None-----	---	---	>6.0	---	---	Low-----	Moderate	Low.
Hecla-----	A	None-----	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
124-----Marysland	B/D	Rare-----	---	---	1.0-2.5	Apparent	Nov-Jul	High-----	High-----	Low.
127*. Pits										
136-----Ryan	D	Occasional	Brief to long.	Mar-Jun	0-1.0	Apparent	Apr-Jul	Moderate	High-----	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
137------------- Harriet	D	Occasional	Long------	Apr-Jun	0-1.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
139F------------- Serden	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
145B, 145E-------- Sioux	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
151------------- Stirum	B/D	None--------	---	---	1.0-3.0	Apparent	Apr-Jul	Moderate	High-----	Moderate.
157------------- Swenoda	B	None--------	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High-----	Moderate.
158B*:										
Swenoda----------	B	None--------	---	---	2.5-4.0	Perched	Mar-Jun	Moderate	High-----	Moderate.
Barnes----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
163B------------- Towner	B	None--------	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High-----	Low.
164C*:										
Towner----------	B	None--------	---	---	3.0-6.0	Perched	Apr-Jun	Moderate	High-----	Low.
Buse------------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Maddock----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
165E*:										
Dickey----------	B	None--------	---	---	>6.0	---	---	Low------	High-----	Low.
Buse------------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Maddock----------	A	None--------	---	---	>6.0	---	---	Low------	Moderate	Low.
172------------- Ulen	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low------	Low.
175*:										
Ulen------------	B	None--------	---	---	2.5-6.0	Apparent	Apr-Jul	Moderate	Low------	Low.
Hecla-----------	A	None--------	---	---	3.0-6.0	Apparent	Apr-Oct	Moderate	Moderate	Low.
176B------------- Velva	B	Occasional	Very brief to brief.	Mar-Jun	>6.0	---	---	Moderate	High-----	Low.
177------------- LaDelle	B	Occasional	Brief-----	Apr-Jun	4.0-6.0	Apparent	Oct-Jun	High-----	High-----	Low.
180------------- Wyndmere	B	None--------	---	---	2.0-4.0	Apparent	Sep-Jun	High-----	High-----	Moderate.
181------------- Wyndmere	B	None--------	---	---	2.0-5.0	Apparent	Sep-Jun	High-----	High-----	Low.
184------------- Wyrene	B	None--------	---	---	3.0-5.0	Apparent	Mar-Jun	Moderate	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
185------------- Karlsruhe	B	None---------	---	---	2.5-5.0	Apparent	Apr-Jun	Moderate	High-----	Low.
186, 186B--------- Williams	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
187C*:										
Williams---------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Zahl-------------	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
188E*:										
Zahl-------------	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Williams---------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
188F*:										
Zahl-------------	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Max--------------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Svea-------------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
189*, 189B*:										
Williams---------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Niobell----------	C	None---------	---	---	>6.0	---	---	Moderate	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

Dashes indicate data were not available. LL means liquid limit; PI, plasticity index; MD, maximum dry density; OM, optimum moisture; and NP, nonplastic

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution										Moisture density	
			Percentage passing sieve--					Percentage smaller than--			LL	PI	MD	OM
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm				
											Pct		Lb/ft³	Pct
Aylmer fine sand: (S81ND-049-12)														
C1------ 3 to 26	A-3(0)	SP-SM	100	100	100	99	5	---	1	---	---	NP	116	14
C'1----- 43 to 56	A-2-4(0)	SM	100	100	100	100	13	---	2	---	---	NP	116	14
Bantry fine sand: (S83NP-049-31)														
C1------ 5 to 34	A-3(0)	SP-SM	100	100	100	95	5	---	2	---	---	NP	120	13
C2------ 34 to 60	A-2-4(0)	SM	100	100	100	94	14	---	4	---	---	NP	124	11
Buse loam: (S82ND-049-61)														
Bk1----- 7 to 16	A-6(8)	CL	100	100	100	90	65	---	28	---	34	14	124	11
C------- 28 to 60	A-6(5)	CL	100	98	90	77	53	---	20	---	31	14	128	9
Embden fine sandy loam: (S83ND-049-213)														
Bw1----- 8 to 24	A-4(5)	ML	100	100	100	100	62	---	14	---	26	4	118	13
C1------ 50 to 62	A-4(0)	SM	100	100	100	100	43	---	8	---	---	NP	114	15
Falsen coarse sand: (S85ND-049-353)														
C1------ 20 to 42	A-3(0)	SP-SM	100	100	100	69	10	---	4	---	---	NP	126	10
C2------ 42 to 60	A-3(0)	SP-SM	100	99	99	68	7	---	2	---	---	NP	122	11
Fossum fine sandy loam: (S84ND-049-137)														
Bw------ 14 to 26	A-2-4(0)	SM	100	100	100	99	18	---	8	---	---	NP	113	13
C1------ 26 to 37	A-2-4(0)	SM	100	100	100	100	19	---	4	---	---	NP	120	13
Glyndon silt loam: (S81ND-049-24)														
Bk1----- 11 to 23	A-6(9)	CL	100	100	100	100	87	---	36	---	32	12	112	15
C------- 37 to 60	A-4(8)	ML	100	100	100	100	99	---	17	---	29	4	115	14

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft^3	Pct
Great Bend silty clay loam: (S81ND-049-18)														
Bk------ 14 to 21	A-6(11)	CL	100	100	100	100	75	---	39	---	36	18	110	16
BCk----- 21 to 39	A-6(13)	CL	100	100	100	100	73	---	43	---	38	22	113	15
Harriet silt loam: (S81ND-049-20)														
Bt------ 1 to 9	A-7-6(12)	CL	100	100	100	100	75	---	30	---	42	20	109	17
BCk1---- 23 to 35	A-7-6(17)	CL	100	100	100	100	76	---	39	---	47	31	114	15
Hecla loamy fine sand: (S81ND-049-13)														
AC------ 15 to 30	A-2-4(0)	SM	100	100	100	97	18	---	2	---	---	NP	120	13
C2------ 36 to 52	A-2-4(0)	SM	100	100	100	97	12	---	4	---	---	NP	124	11
Karlsruhe coarse sandy loam: (S83ND-049-159)														
Bk------ 15 to 20	A-2-4(0)	SM	100	100	99	67	15	---	8	---	23	7	128	10
C2------ 39 to 60	A-1-b(0)	SP-SM	99	98	95	42	6	---	2	---	---	NP	122	12
Lohnes loamy coarse sand: (S84ND-049-168)														
Bw1----- 11 to 17	A-2-4(0)	SM	100	100	99	56	12	---	1	---	---	NP	122	12
C1------ 28 to 49	A-1-b(0)	SP-SM	100	100	99	37	5	---	0	---	---	NP	114	15
Ludden silty clay: (S84ND-049-23)														
Bzg2---- 12 to 17	A-7-6(19)	CH	100	100	100	100	97	---	47	---	55	33	111	16
Cg------ 43 to 60	A-7-6(20)	CH	100	100	100	99	93	---	73	---	76	47	103	19
Maddock loamy fine sand: (S81ND-049-29)														
C1------ 15 to 43	A-2-4(0)	SM	100	100	100	99	20	---	4	---	---	NP	118	14

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	depth	Classification AASHTO	Classification Unified	Grain-size distribution: Percentage passing sieve-- 3/8 inch	No. 4	No. 10	No. 40	No. 200	Percentage smaller than-- .02 mm	.005 mm	.002 mm	LL	PI	Moisture density MD	OM
												Pct		Lb/ft3	Pct
Ryan silty clay: (S84ND-049-201)															
Bt------	1 to 10	A-7-6(20)	CH	100	100	100	100	95	---	45	---	71	42	103	19
Bkzg2---	23 to 35	A-7-6(20)	CH	100	100	100	100	98	---	50	---	66	45	114	15
Stirum fine sandy loam: (S84ND-049-62)															
Bk1-----	12 to 20	A-6(9)	CL	100	100	100	100	75	---	39	---	28	13	117	14
C1------	29 to 42	A-4(8)	ML	100	100	100	100	78	---	19	---	25	4	122	12
Svea loam: (S82ND-049-55)															
Bw1-----	9 to 22	A-6(10)	CL	100	100	100	97	86	---	30	---	35	15	108	17
BCk-----	32 to 45	A-6(11)	CL	100	99	97	90	68	---	32	---	36	21	123	11
Swenoda fine sandy loam: (S81ND-049-25)															
Bw1-----	14 to 27	A-2-4(0)	SM	100	100	100	100	30	---	8	---	---	NP	123	11
2C------	40 to 60	A-7-6(18)	CL	100	100	100	100	91	---	59	---	52	32	105	18
Towner loamy fine sand: (S84ND-049-300)															
Bw1-----	17 to 28	A-2-4(0)	SM	100	100	100	96	22	---	4	---	---	NP	125	11
2C------	56 to 64	A-6(8)	CL	100	100	100	99	97	---	23	---	33	11	120	13
Ulen fine sandy loam: (S82ND-049-54)															
BCk1----	20 to 30	A-2-4(0)	SM	100	100	100	97	26	---	8	---	---	NP	125	11
BCk2----	30 to 50	A-4(7)	ML	100	100	100	99	69	---	18	---	26	4	121	13
Verendrye coarse sandy loam: (S84ND-049-167)															
C-------	18 to 30	A-3(0)	SP-SM	100	100	100	51	8	---	2	---	---	NP	---	---

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution								LL	PI	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
											Pct		Lb/ft³	Pct
Williams loam: (S84ND-049-178)														
Bt2----- 11 to 18	A-7-6(12)	CL	98	97	96	92	69	---	35	---	42	22	116	14
C1------ 47 to 57	A-7-6(15)	CL	100	100	100	93	71	---	34	---	43	27	119	13
Wyndmere fine sandy loam: (S81ND-049-26)														
Bk1----- 9 to 25	A-4(5)	CL	100	100	100	100	62	---	31	---	25	8	115	14
C2------ 48 to 60	A-4(0)	SM	100	100	100	100	41	---	8	---	---	NP	120	12

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aberdeen	Fine, montmorillonitic Glossic Udic Natriborolls
Arveson	Coarse-loamy, frigid Typic Calciaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Aylmer	Mixed, frigid Aquic Udipsamments
Bantry	Mixed, frigid Typic Psammaquents
Barnes	Fine-loamy, mixed Udic Haploborolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Cavour	Fine, montmorillonitic Udic Natriborolls
Claire	Mixed, frigid Typic Udipsamments
Colvin	Fine-silty, frigid Typic Calciaquolls
Cresbard	Fine, montmorillonitic Glossic Udic Natriborolls
Dickey	Sandy over loamy, mixed Udorthentic Haploborolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Embden	Coarse-loamy, mixed Pachic Udic Haploborolls
Falsen	Sandy, mixed Aquic Haploborolls
Fargo	Fine, montmorillonitic, frigid Vertic Haplaquolls
Fossum	Sandy, mixed (calcareous), frigid Typic Haplaquolls
Gardena	Coarse-silty, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Great Bend	Fine-silty, mixed Udic Haploborolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, montmorillonitic, frigid Typic Natraquolls
Hecla	Sandy, mixed Aquic Haploborolls
Karlsruhe	Sandy, frigid Aeric Calciaquolls
LaDelle	Fine-silty, mixed Cumulic Udic Haploborolls
Larson	Fine-loamy, mixed Udic Natriborolls
Letcher	Coarse-loamy, mixed Udic Natriborolls
Lohnes	Sandy, mixed Udorthentic Haploborolls
Ludden	Fine, montmorillonitic (calcareous), frigid Vertic Haplaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Max	Fine-loamy, mixed Typic Haploborolls
Minnewaukan	Mixed, frigid Typic Psammaquents
Miranda	Fine-loamy, mixed Leptic Natriborolls
Niobell	Fine-loamy, mixed Glossic Natriborolls
Overly	Fine-silty, mixed Pachic Udic Haploborolls
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Rifle	Euic Typic Borohemists
Ryan	Fine, montmorillonitic, frigid Typic Natraquolls
Serden	Mixed, frigid Typic Udipsamments
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Southam	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Stirum	Coarse-loamy, mixed, frigid Typic Natraquolls
Svea	Fine-loamy, mixed Pachic Udic Haploborolls
Swenoda	Coarse-loamy, mixed Pachic Udic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Towner	Sandy over loamy, mixed Udorthentic Haploborolls
Ulen	Sandy, frigid Aeric Calciaquolls
Velva	Coarse-loamy, mixed Fluventic Haploborolls
Verendrye	Sandy, mixed (calcareous), frigid Typic Haplaquolls
Williams	Fine-loamy, mixed Typic Argiborolls
Wyndmere	Coarse-loamy, frigid Aeric Calciaquolls
Wyrene	Sandy, frigid Aeric Calciaquolls
Zahl	Fine-loamy, mixed Entic Haploborolls

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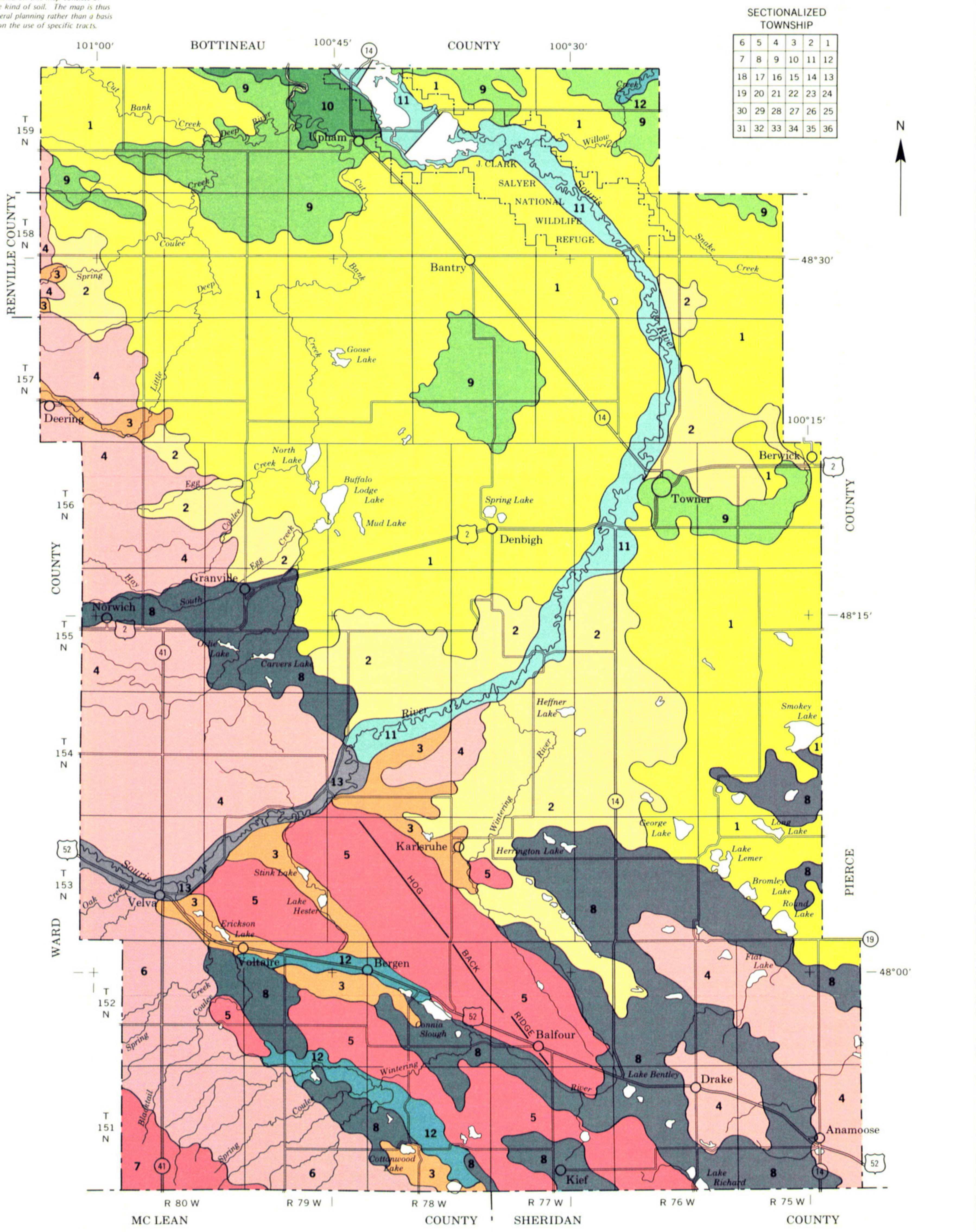
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



LEGEND*

LEVEL TO HILLY, SANDY AND LOAMY SOILS ON DELTA PLAINS AND OUT WASH PLAINS

1 — HECLA-AYLMER-ULEN association: Deep, coarse textured and moderately coarse textured, level to undulating, moderately well drained and somewhat poorly drained soils

2 — LOHNES-FALSEN-KARLSRUHE association: Deep, coarse textured and moderately coarse textured, level to rolling, well drained to somewhat poorly drained soils

3 — ARVILLA-SIOUX-LOHNES association: Deep, moderately coarse textured and coarse textured, level to hilly, excessively drained to well drained soils

LEVEL TO VERY STEEP, LOAMY AND SILTY SOILS ON TILL PLAINS AND MORAINES

4 — BARNES-SVEA-BUSE association: Deep, medium textured, level to hilly, well drained and moderately well drained soils

5 — BARNES-CRESBARD-CAVOUR association: Deep, medium textured, level to undulating, well drained and moderately well drained soils

6 — WILLIAMS-ZAHL association: Deep, medium textured, level to very steep, well drained soils

7 — WILLIAMS-ZAHL-PARNELL association: Deep, medium textured and moderately fine textured, level to hilly, well drained and very poorly drained soils

LEVEL TO UNDULATING, SANDY AND LOAMY SOILS ON TILL PLAINS, LACUSTRINE PLAINS, AND DELTA PLAINS

8 — TOWNER-SWENODA-HECLA association: Deep, coarse textured and moderately coarse textured, level to undulating, moderately well drained soils

LEVEL TO UNDULATING, LOAMY AND SILTY SOILS ON LACUSTRINE PLAINS

9 — EMBDEN-WYNDMERE-GARDENA association: Deep, moderately coarse textured and medium textured, level and nearly level, moderately well drained and somewhat poorly drained soils

10 — GREAT BEND-EGELAND-OVERLY association: Deep, moderately fine textured to moderately coarse textured, level to undulating, well drained and moderately well drained soils

LEVEL TO UNDULATING, CLAYEY, LOAMY, AND SILTY SOILS ON BOTTOM LAND AND TERRACES

11 — LUDDEN association: Deep, fine textured, level, poorly drained and very poorly drained soils

12 — HARRIET-RYAN association: Deep, medium textured, level, poorly drained, alkali soils

13 — VELVA-LADELLE-HARRIET association: Deep, medium textured and moderately fine textured, level to undulating, well drained, moderately well drained, and poorly drained soils

*The texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA COOPERATIVE EXTENSION SERVICE
NORTH DAKOTA STATE SOIL CONSERVATION COMMITTEE

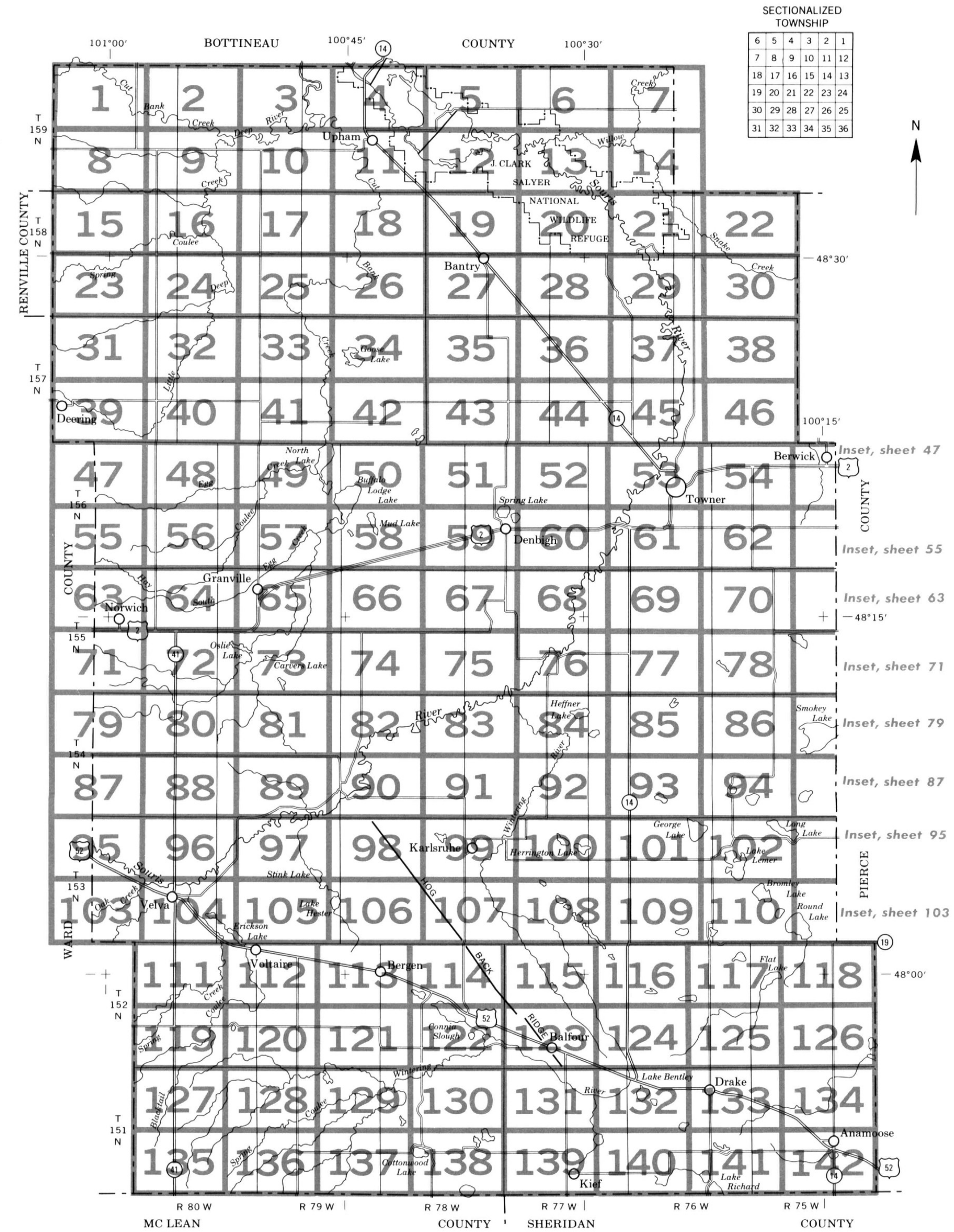
GENERAL SOIL MAP

MC HENRY COUNTY
NORTH DAKOTA

Scale 1:316,800

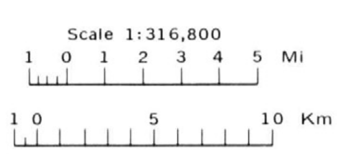
1 0 1 2 3 4 5 Mi

1 0 5 10 Km



INDEX TO MAP SHEETS

MC HENRY COUNTY
NORTH DAKOTA



SOIL LEGEND

Map symbols consist of a number or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
1	Tonka silt loam
2	Parnell silty clay loam
5	Southam silt loam
6	Rifle mucky peat
10	Aberdeen-Great Bend complex, 0 to 3 percent slopes
17B	Arvilla sandy loam, 0 to 6 percent slopes
18B	Aylmer-Bantry fine sands, 0 to 6 percent slopes
19B	Aylmer-Minnewaukan complex, 0 to 6 percent slopes
24B	Barnes-Buse loams, 3 to 6 percent slopes
24C	Barnes-Buse loams, 6 to 9 percent slopes
24D	Buse-Barnes loams, 9 to 15 percent slopes
24E	Buse-Barnes loams, 15 to 25 percent slopes
29	Svea-Barnes loams, 0 to 2 percent slopes
29B	Barnes-Svea loams, 2 to 5 percent slopes
36	Miranda-Cavour loams
37	Cavour-Cresbard loams, 0 to 3 percent slopes
44B	Claire-Lohnes coarse sands, 1 to 6 percent slopes, hummocky
50	Colvin silt loam
51	Colvin silt loam, saline
52	Colvin silt loam, wet
54	Barnes-Cresbard loams, 0 to 3 percent slopes
54B	Barnes-Cresbard loams, 3 to 6 percent slopes
56	Divide loam, 0 to 3 percent slopes
62B	Egeland fine sandy loam, 0 to 6 percent slopes
65	Embden fine sandy loam, 0 to 3 percent slopes
68	Fargo silty clay
72	Verendrye loamy coarse sand
73	Fossum and Arveson soils
74	Fossum fine sandy loam, wet
76	Gardena loam, 0 to 3 percent slopes
79	Glyndon loam, saline
80	Glyndon loam
82	Great Bend-Overly complex, 0 to 3 percent slopes
88	Hamerly loam, saline, 0 to 3 percent slopes
89	Hamerly loam, 0 to 3 percent slopes
90	Hamerly-Tonka complex, 0 to 3 percent slopes
91	Hecla loamy fine sand, 0 to 3 percent slopes
104	Colvin silt loam, channeled
105	Letcher fine sandy loam, 0 to 3 percent slopes
106	Swenoda-Larson fine sandy loams, 0 to 3 percent slopes
106B	Swenoda-Larson fine sandy loams, 3 to 6 percent slopes
107B	Lohnes-Claire coarse sands, 0 to 6 percent slopes
108	Falsen-Karlsruhe complex, 0 to 3 percent slopes
109D	Lohnes and Maddock soils, 6 to 15 percent slopes
110	Ludden clay, ponded
111	Ludden clay
112B	Maddock-Hecla loamy fine sands, 1 to 6 percent slopes
124	Marysland silt loam
127	Pits, gravel
136	Ryan loam
137	Harriet silt loam
139F	Serden sand, 3 to 50 percent slopes
145B	Sioux gravelly sandy loam, 1 to 6 percent slopes
145E	Sioux gravelly sandy loam, 6 to 25 percent slopes
151	Stirum fine sandy loam
157	Swenoda fine sandy loam, 0 to 3 percent slopes
158B	Swenoda-Barnes complex, 0 to 6 percent slopes
163B	Towner loamy fine sand, 0 to 6 percent slopes
164C	Towner-Buse-Maddock complex, 3 to 9 percent slopes
165E	Dickey-Buse-Maddock complex, 9 to 25 percent slopes
172	Ulen fine sandy loam, 0 to 3 percent slopes
175	Ulen-Hecla loamy fine sands, 0 to 3 percent slopes
176B	Velva loam, 0 to 6 percent slopes
177	LaDelle silty clay loam, 0 to 3 percent slopes
180	Wyndmere fine sandy loam, saline
181	Wyndmere fine sandy loam
184	Wyrene sandy loam
185	Karlsruhe coarse sandy loam
186	Williams loam, 0 to 3 percent slopes
186B	Williams loam, 3 to 6 percent slopes
187C	Williams-Zahl loams, 6 to 9 percent slopes
188E	Zahl-Williams loams, 9 to 20 percent slopes
188F	Zahl-Max-Svea loams, 6 to 60 percent slopes
189	Williams-Niobell loams, 0 to 3 percent slopes
189B	Williams-Niobell loams, 3 to 6 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small

PITS

- Gravel pit 5 acres or less
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

- Blowout 1 to 3 acres
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

1

McHENRY COUNTY, NORTH DAKOTA NO. 1

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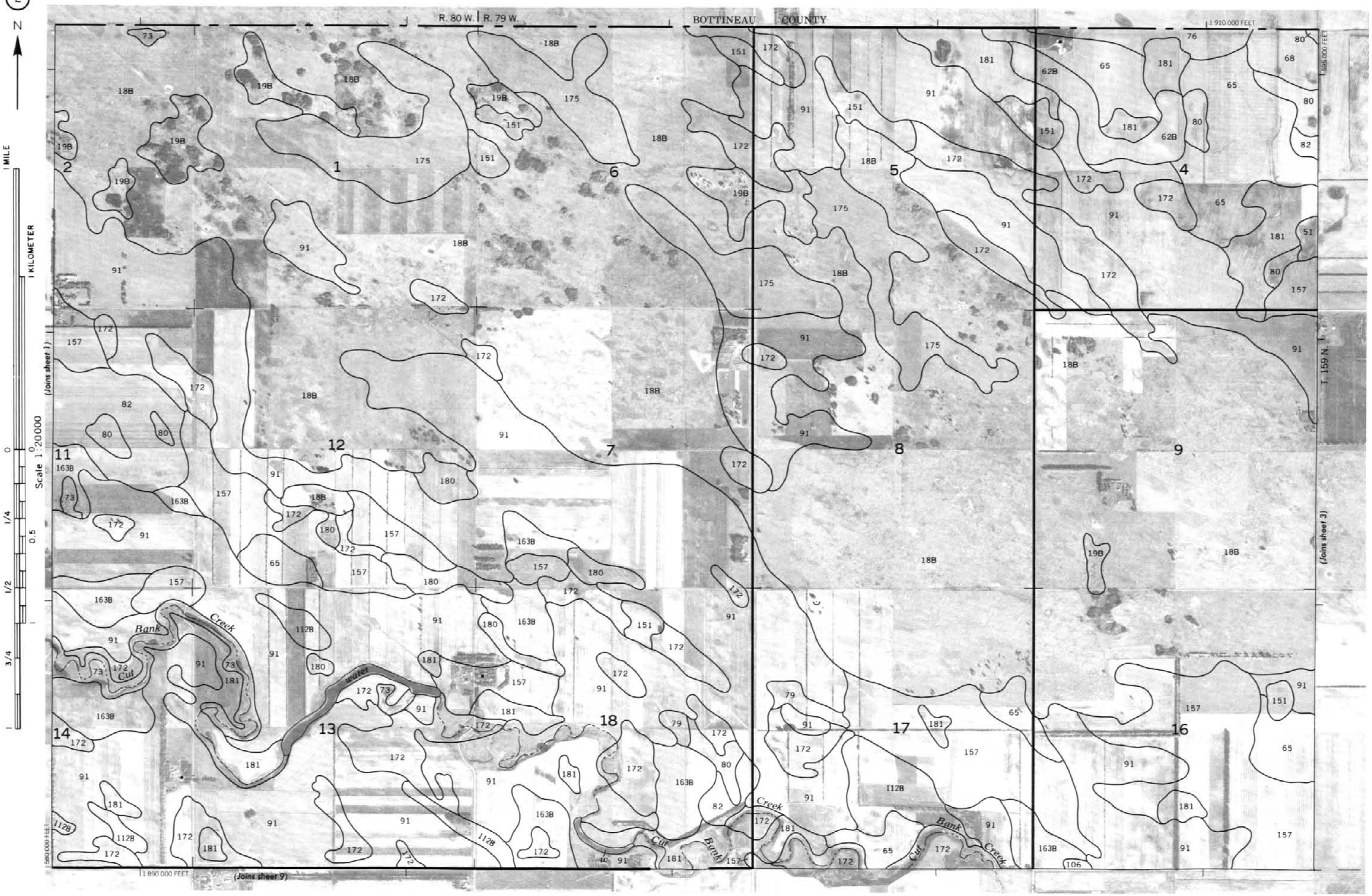
2



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McHENRY COUNTY, NORTH DAKOTA NO. 2

McHENRY COUNTY, NORTH DAKOTA NO. 3

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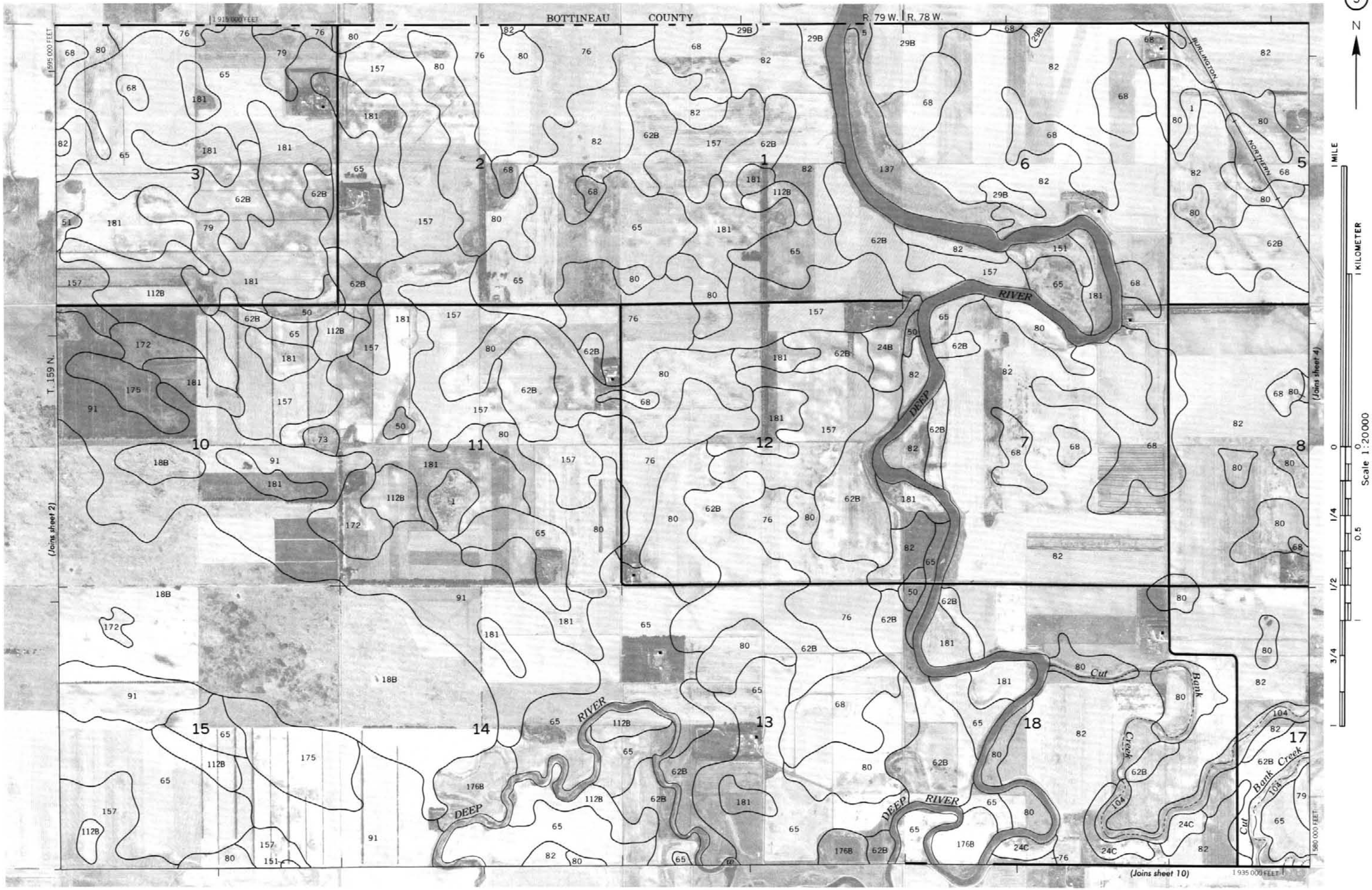

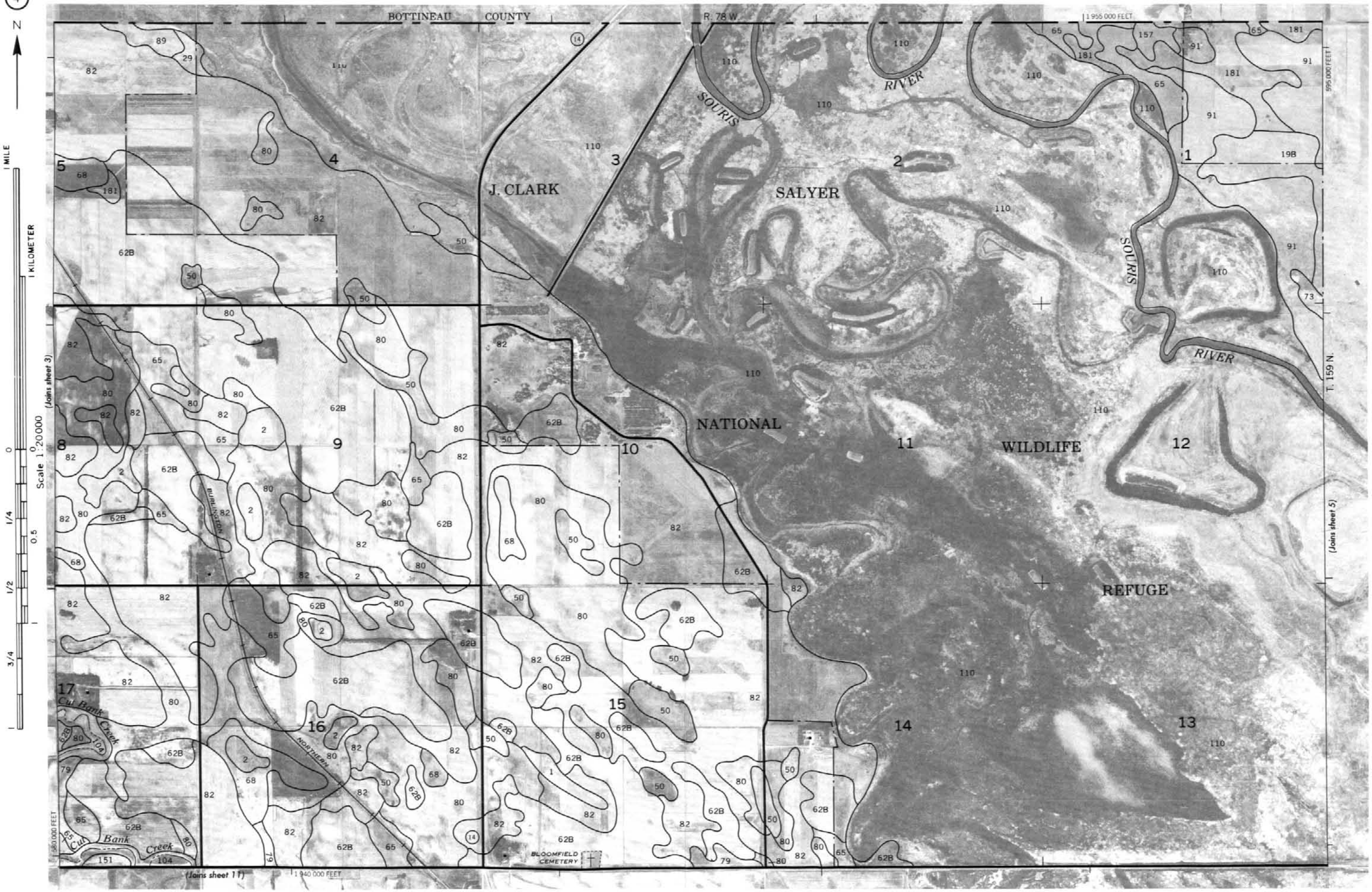

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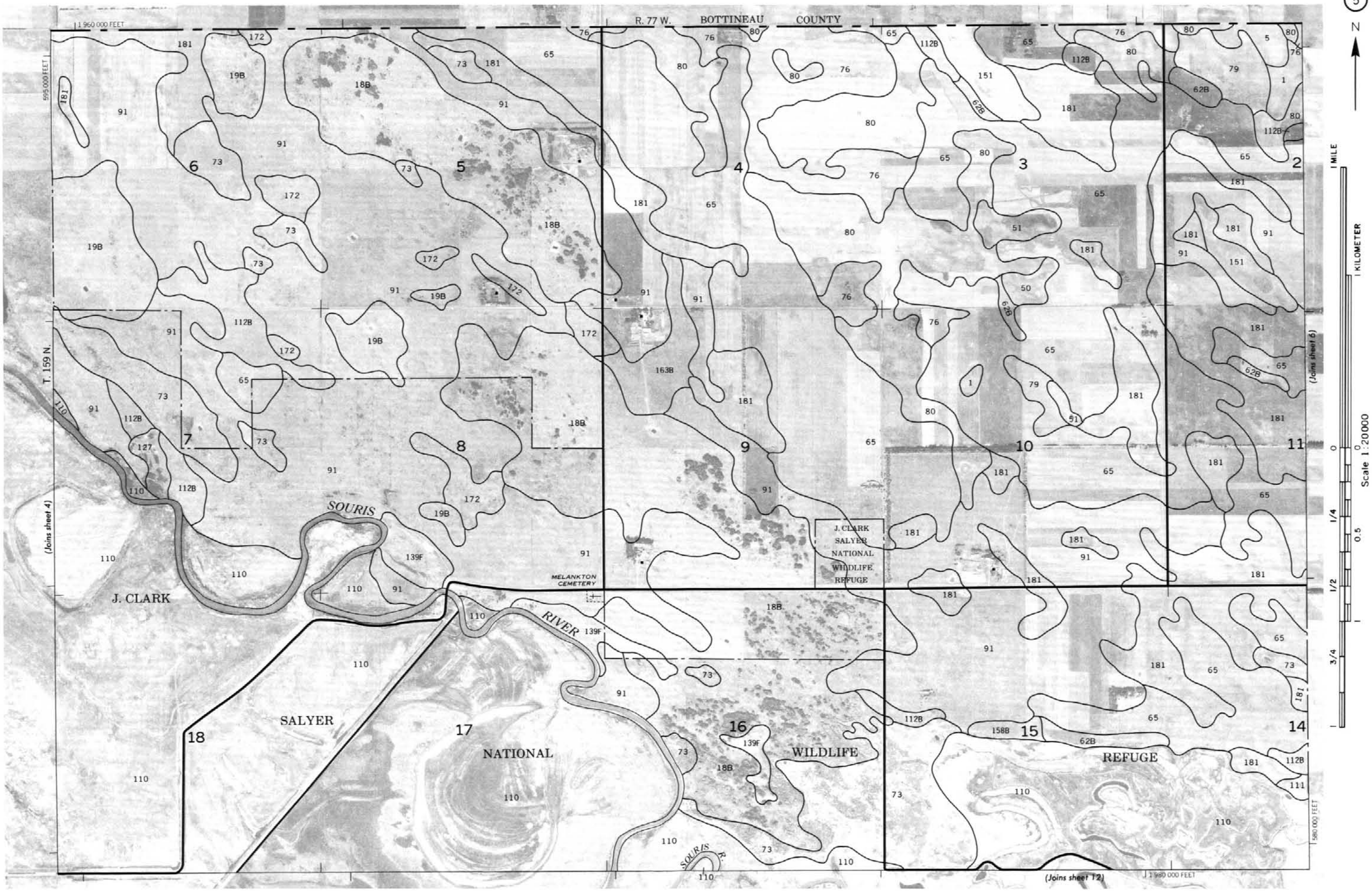
McHENRY COUNTY, NORTH DAKOTA NO. 4

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 5



McHENRY COUNTY, NORTH DAKOTA NO. 5

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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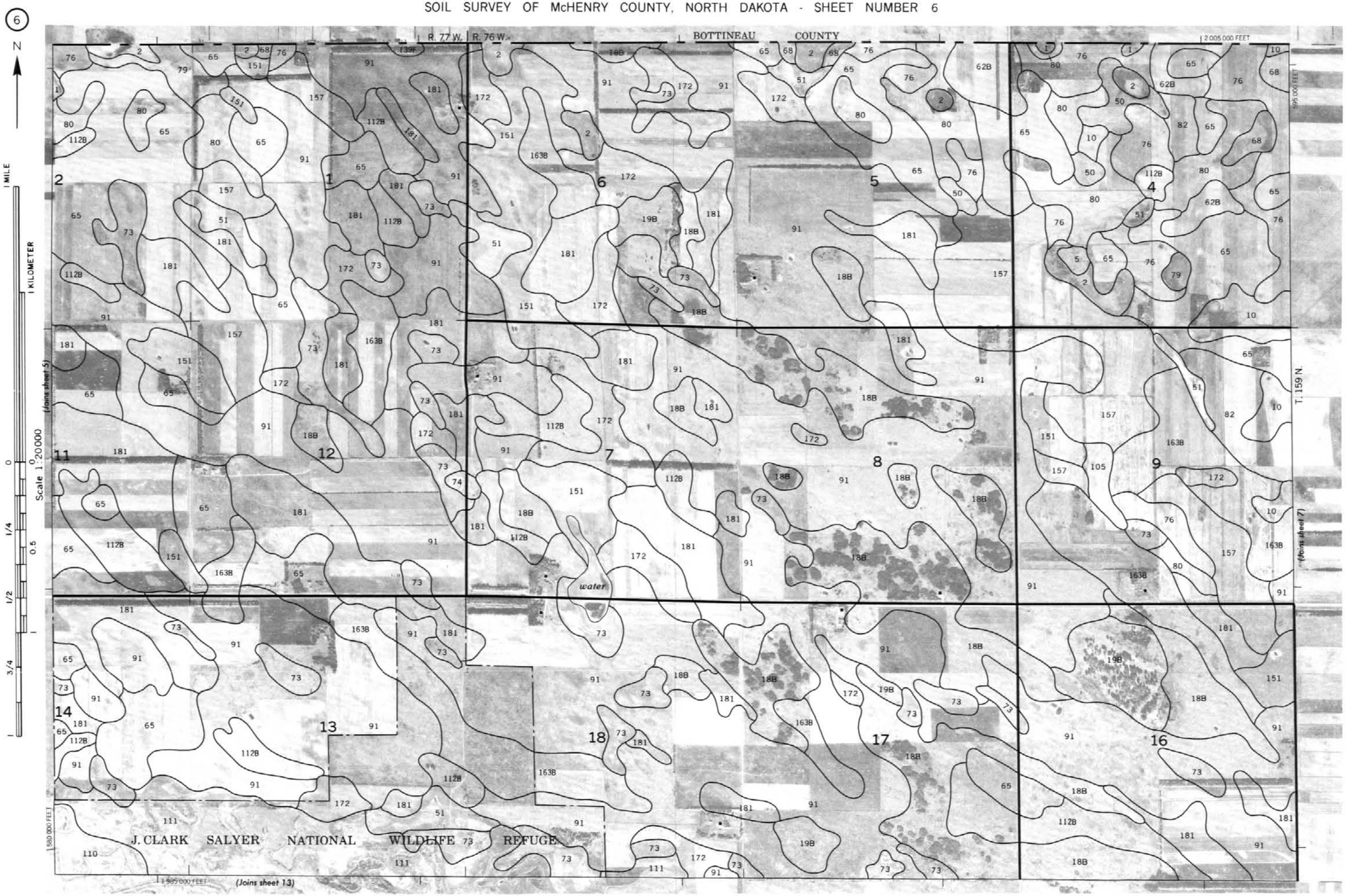
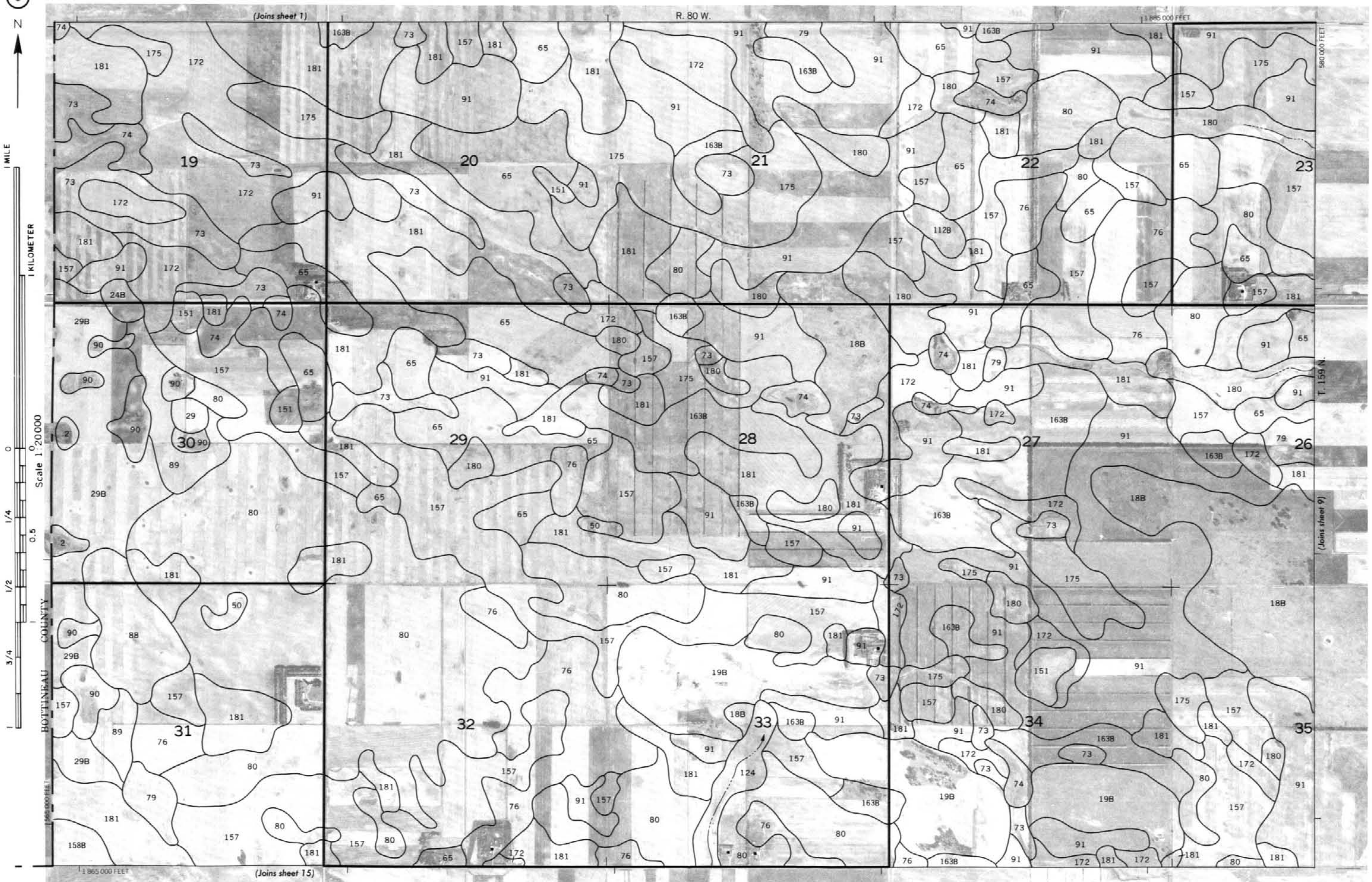


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 7

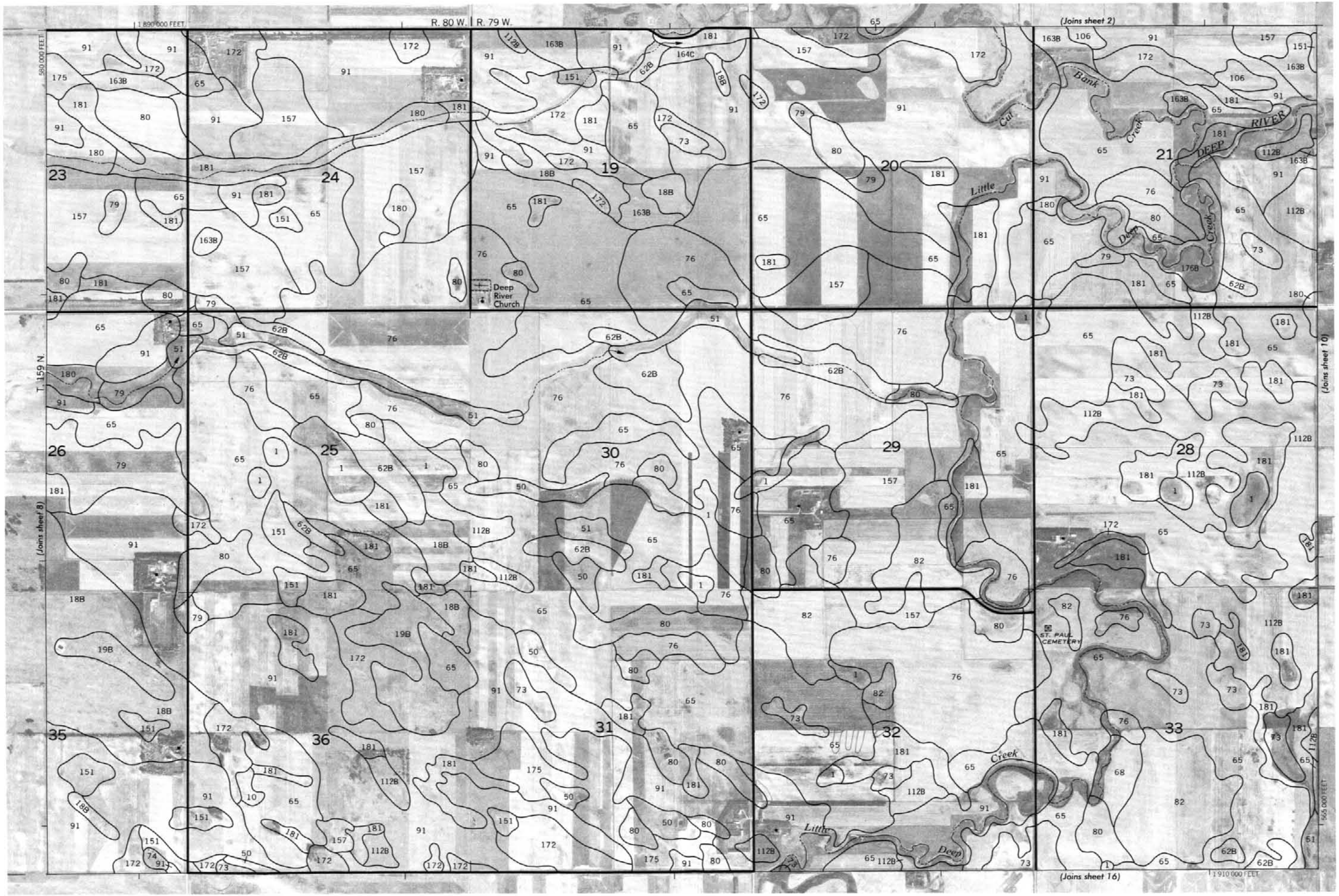
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 8



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 8



McHENRY COUNTY, NORTH DAKOTA NO. 9
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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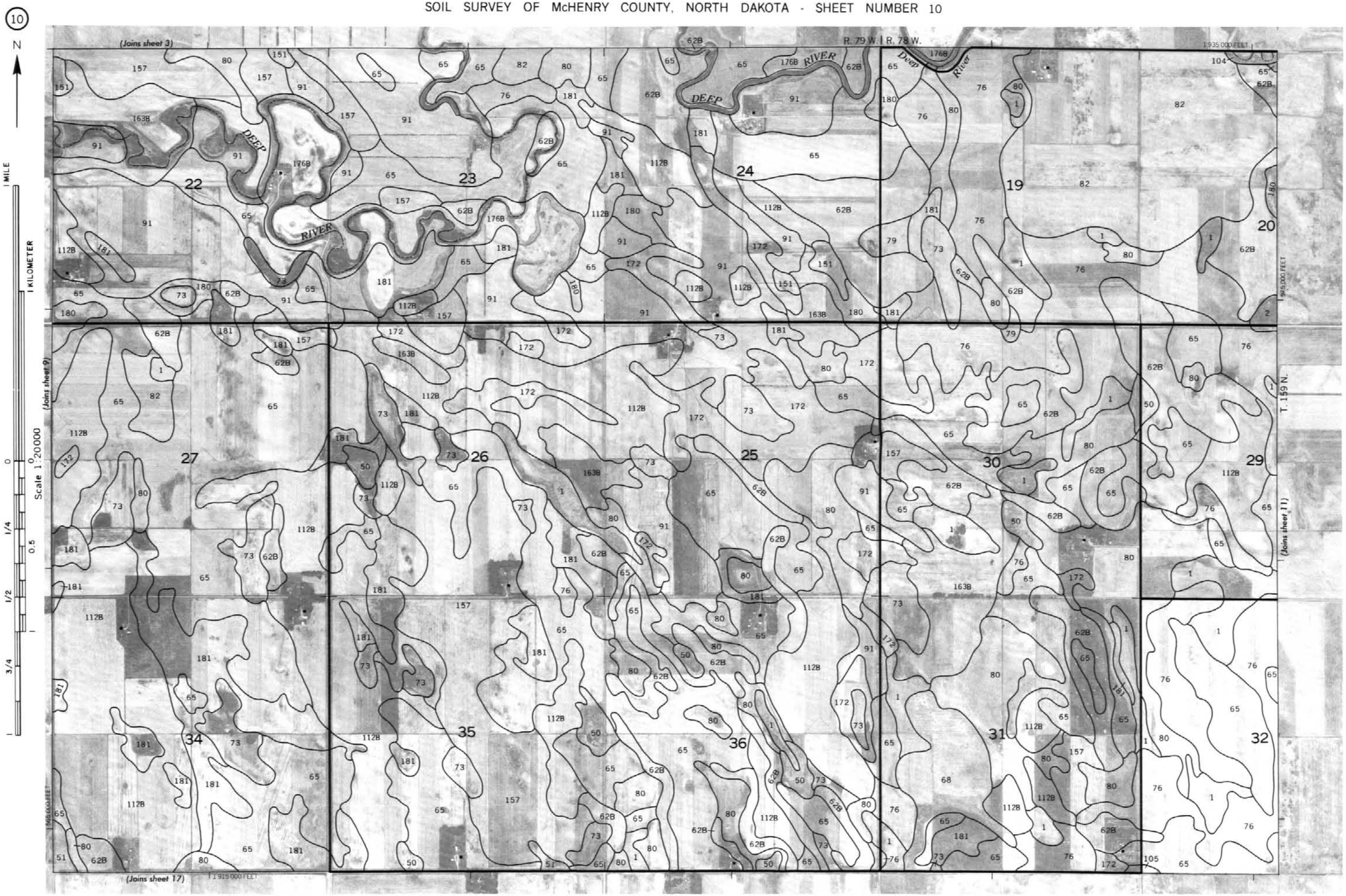

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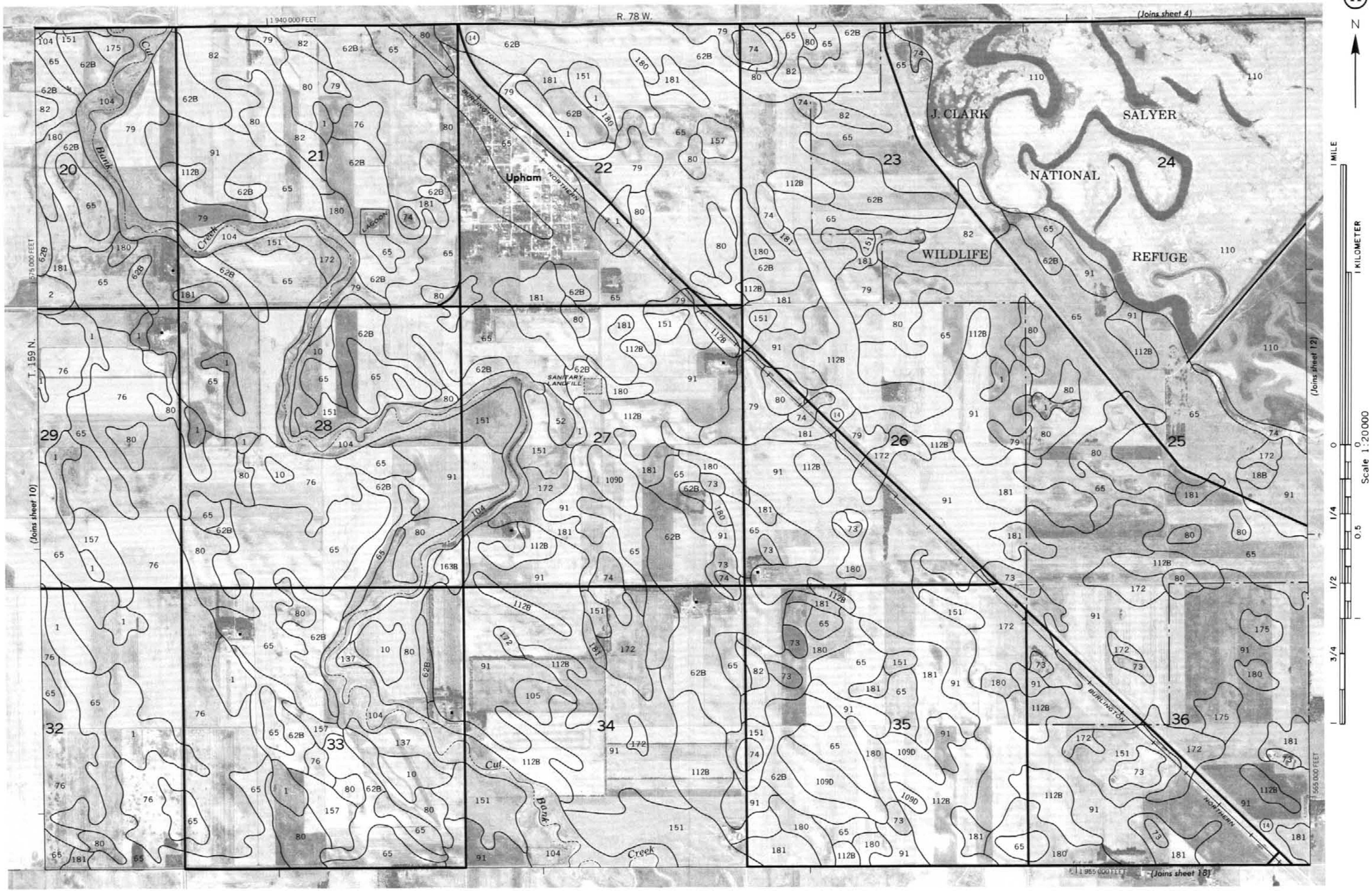
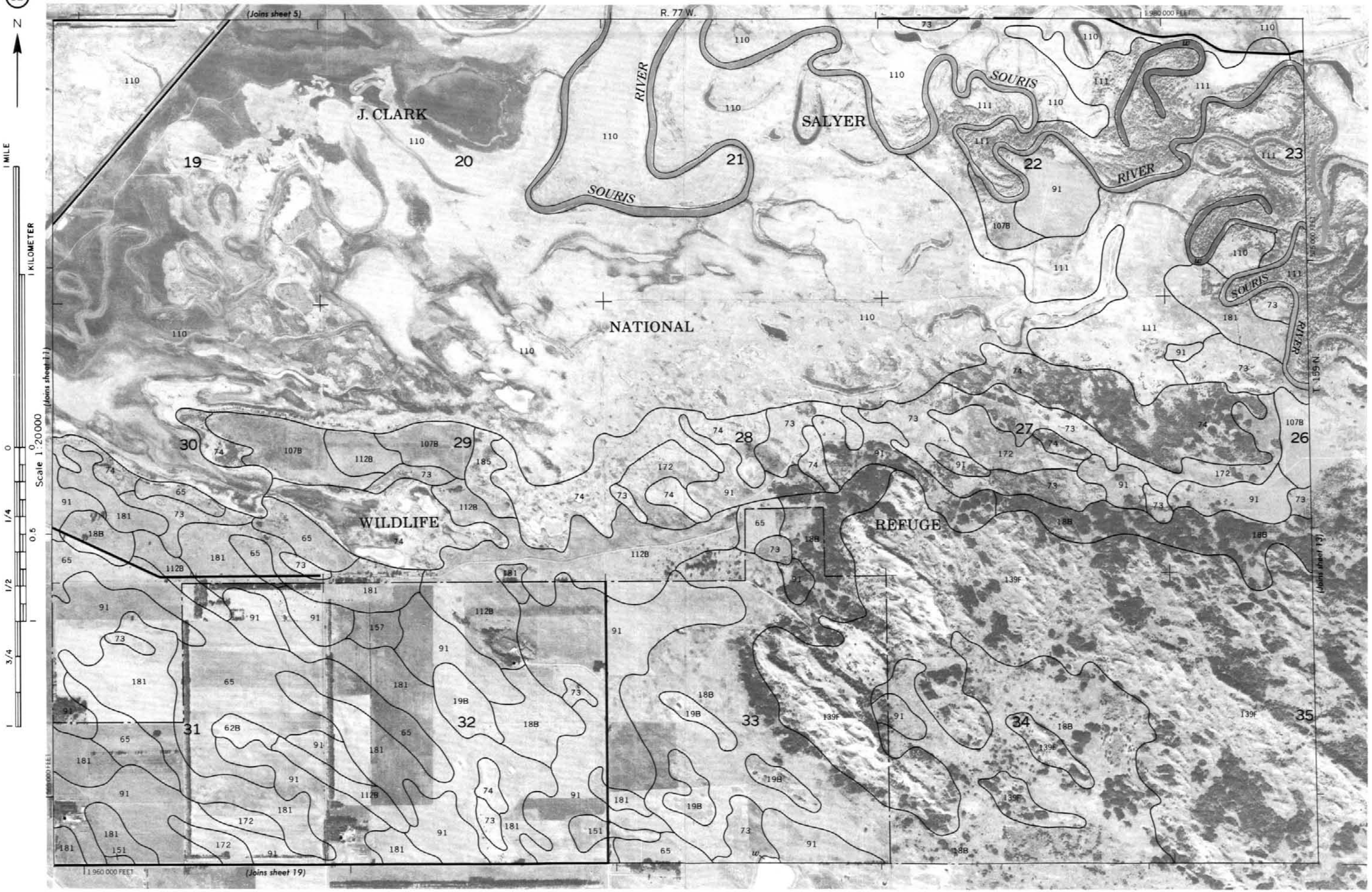


McHENRY COUNTY, NORTH DAKOTA NO. 11

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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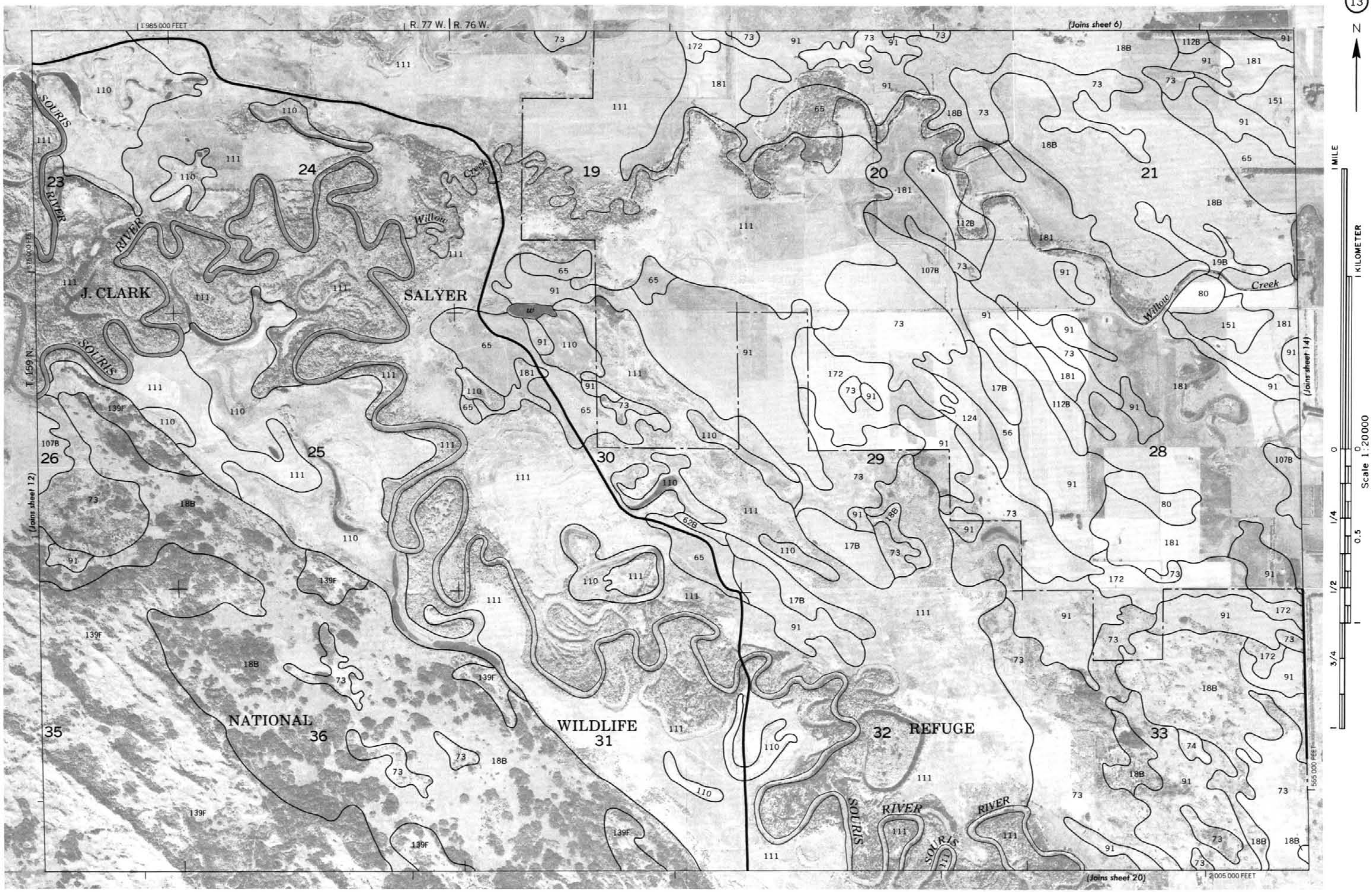
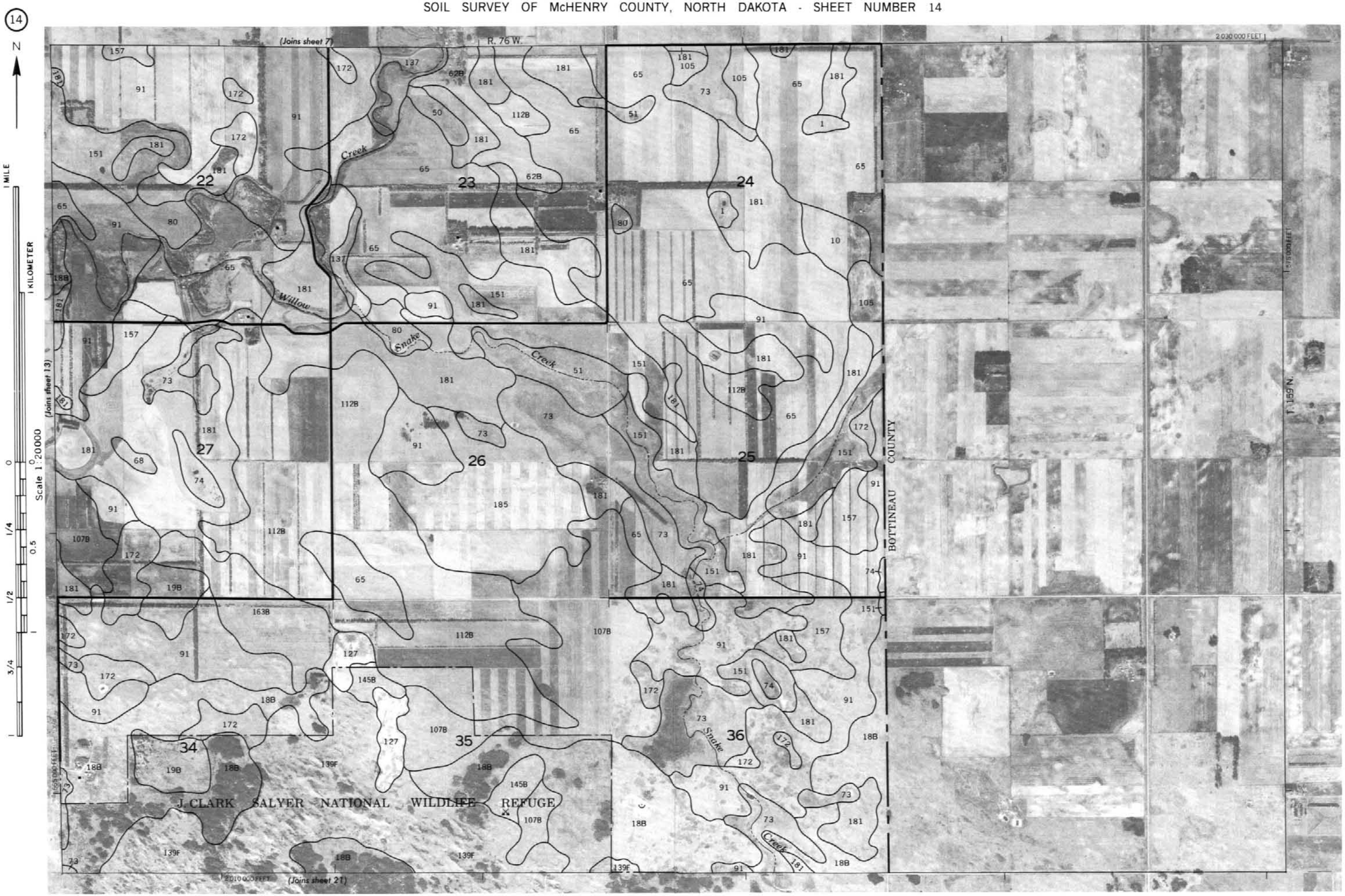
McHENRY COUNTY, NORTH DAKOTA NO. 12



McHENRY COUNTY, NORTH DAKOTA NO. 13

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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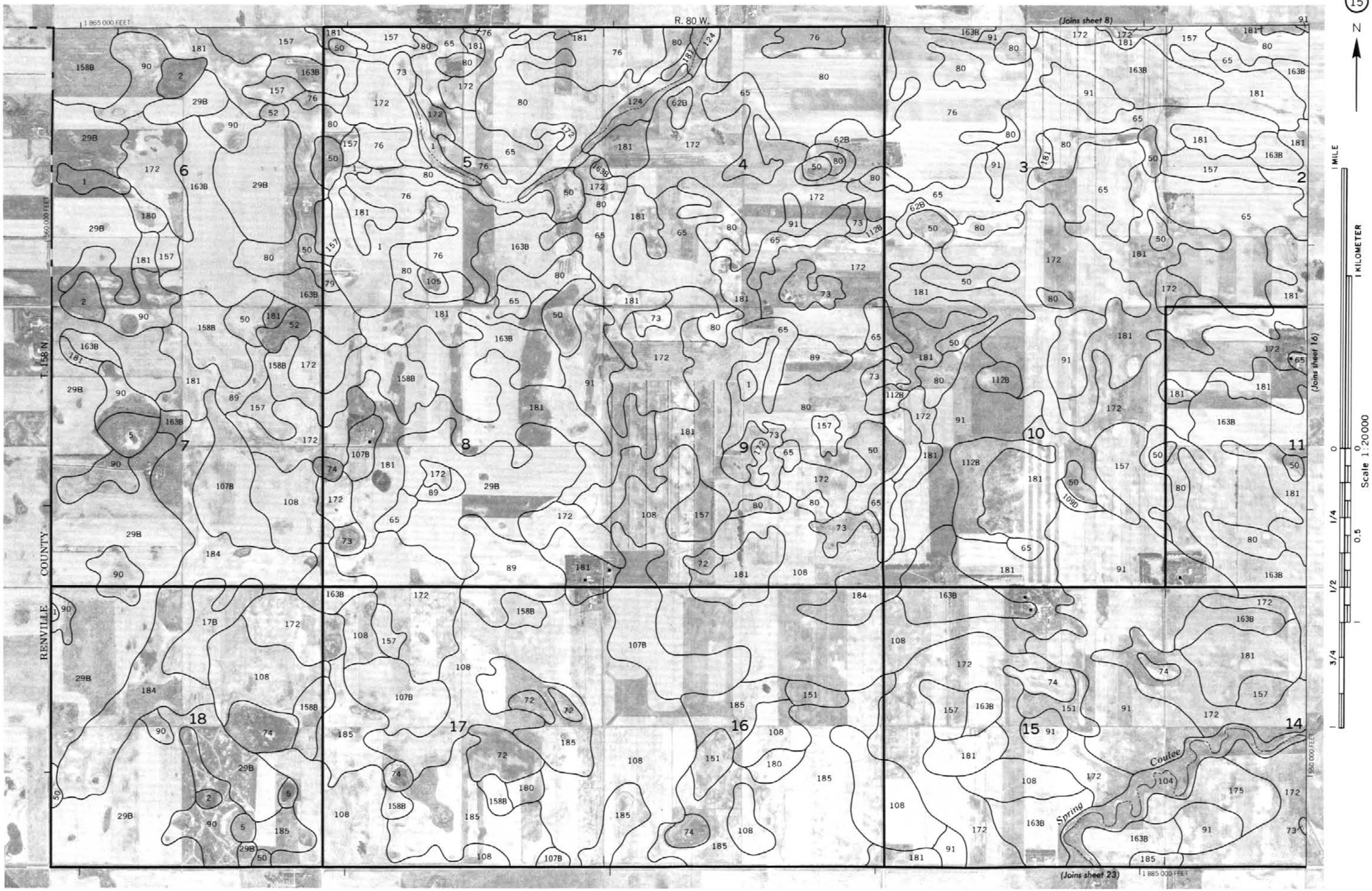
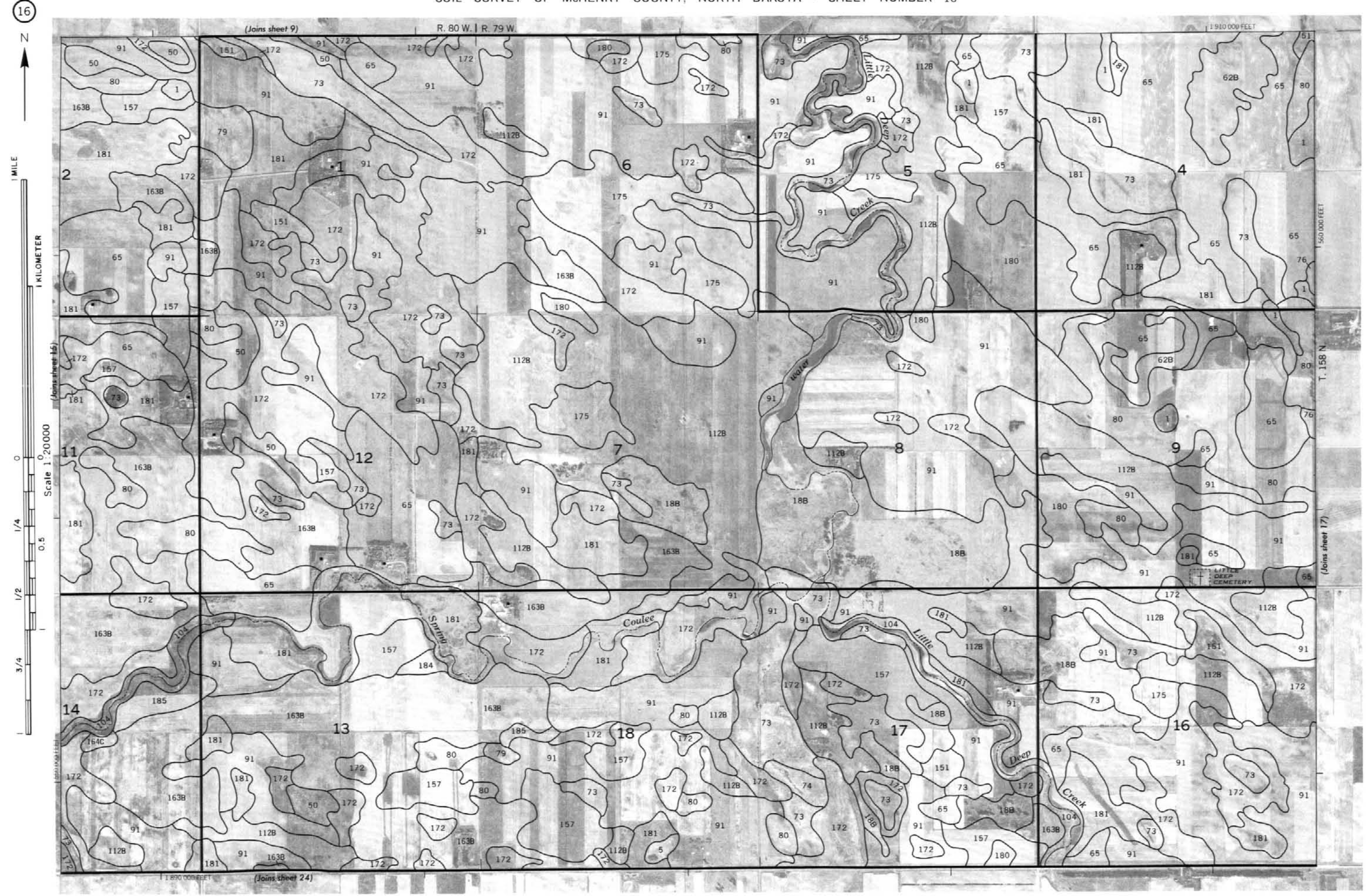


McHENRY COUNTY, NORTH DAKOTA NO. 15

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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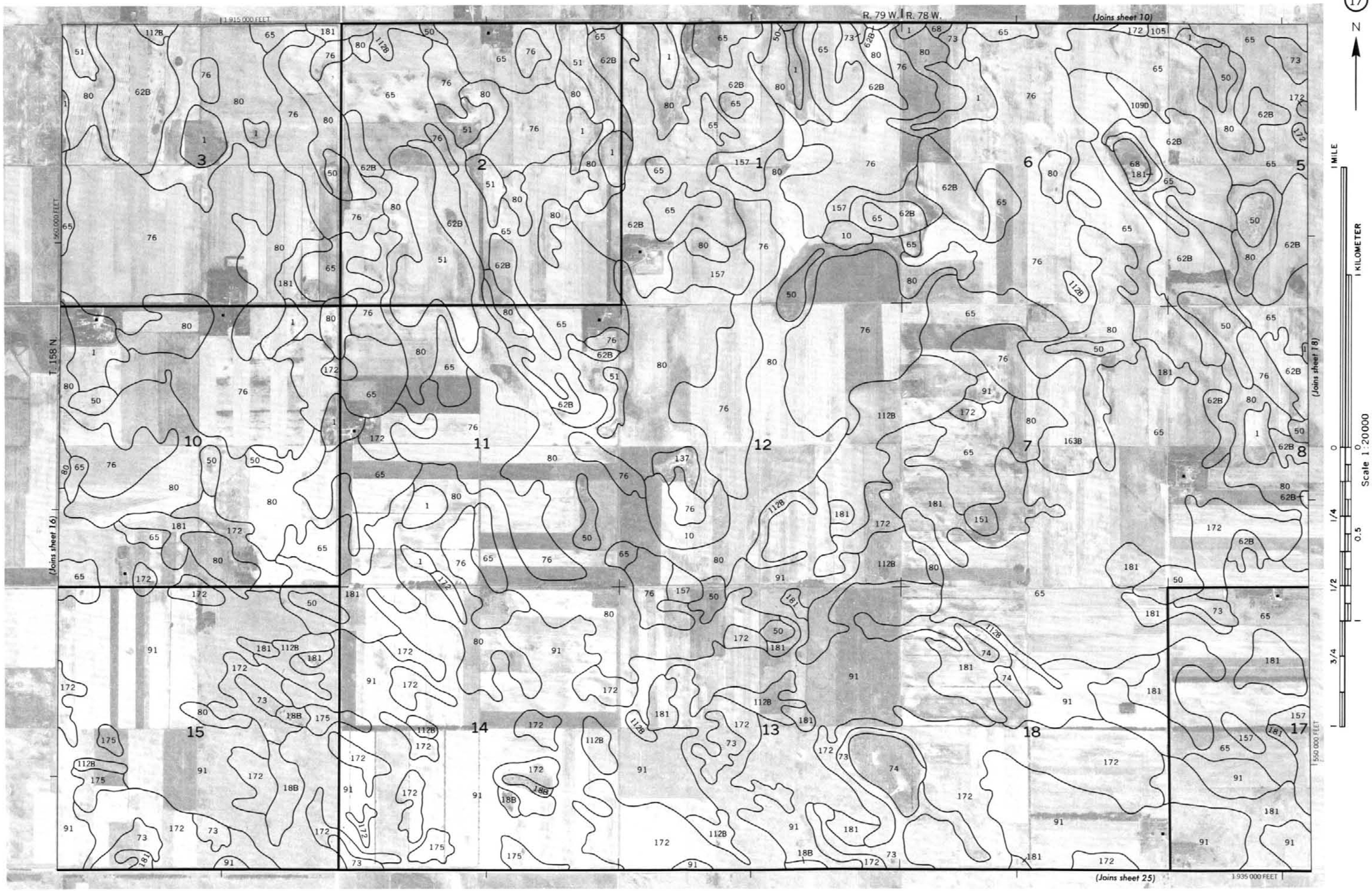
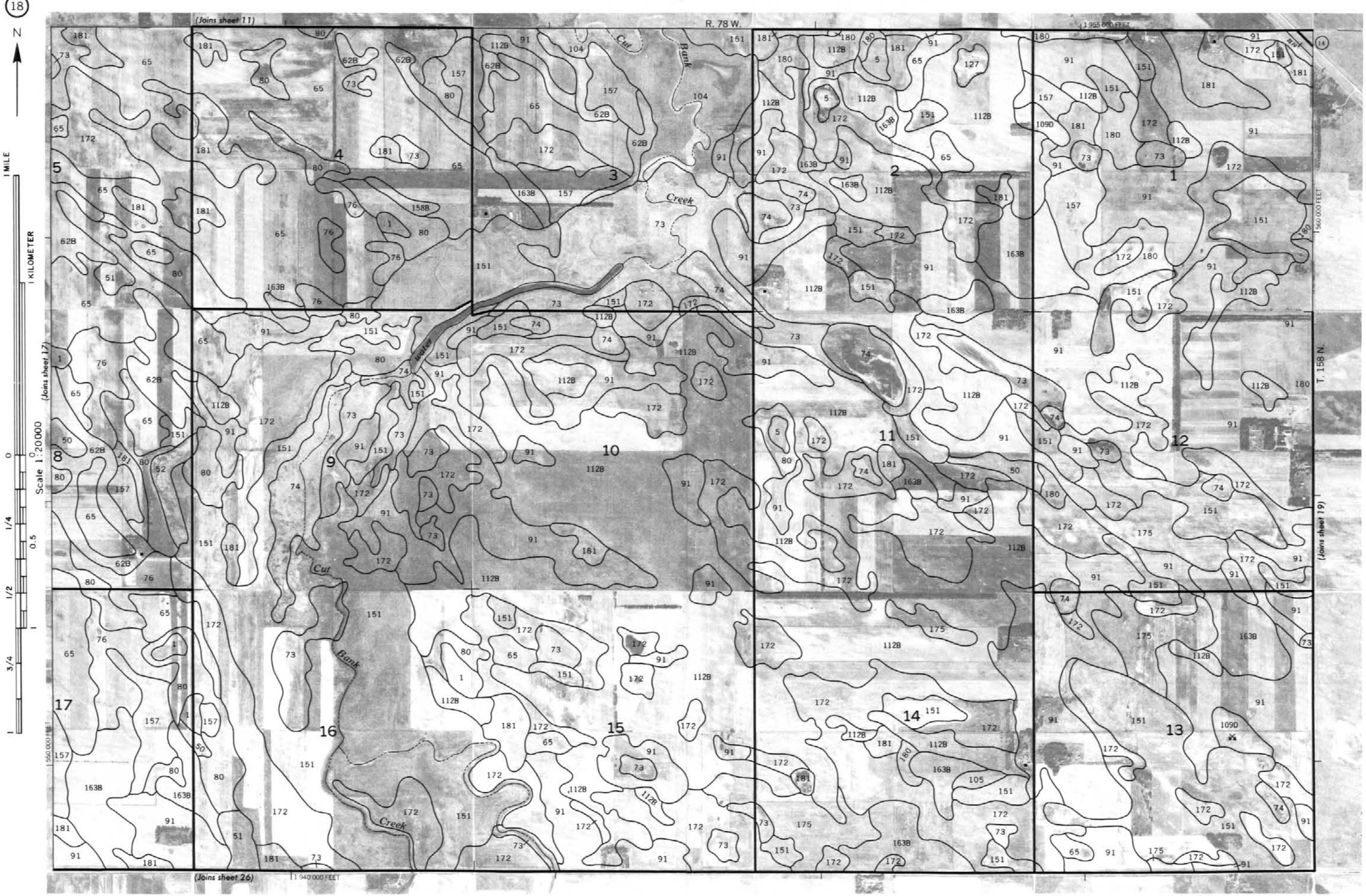


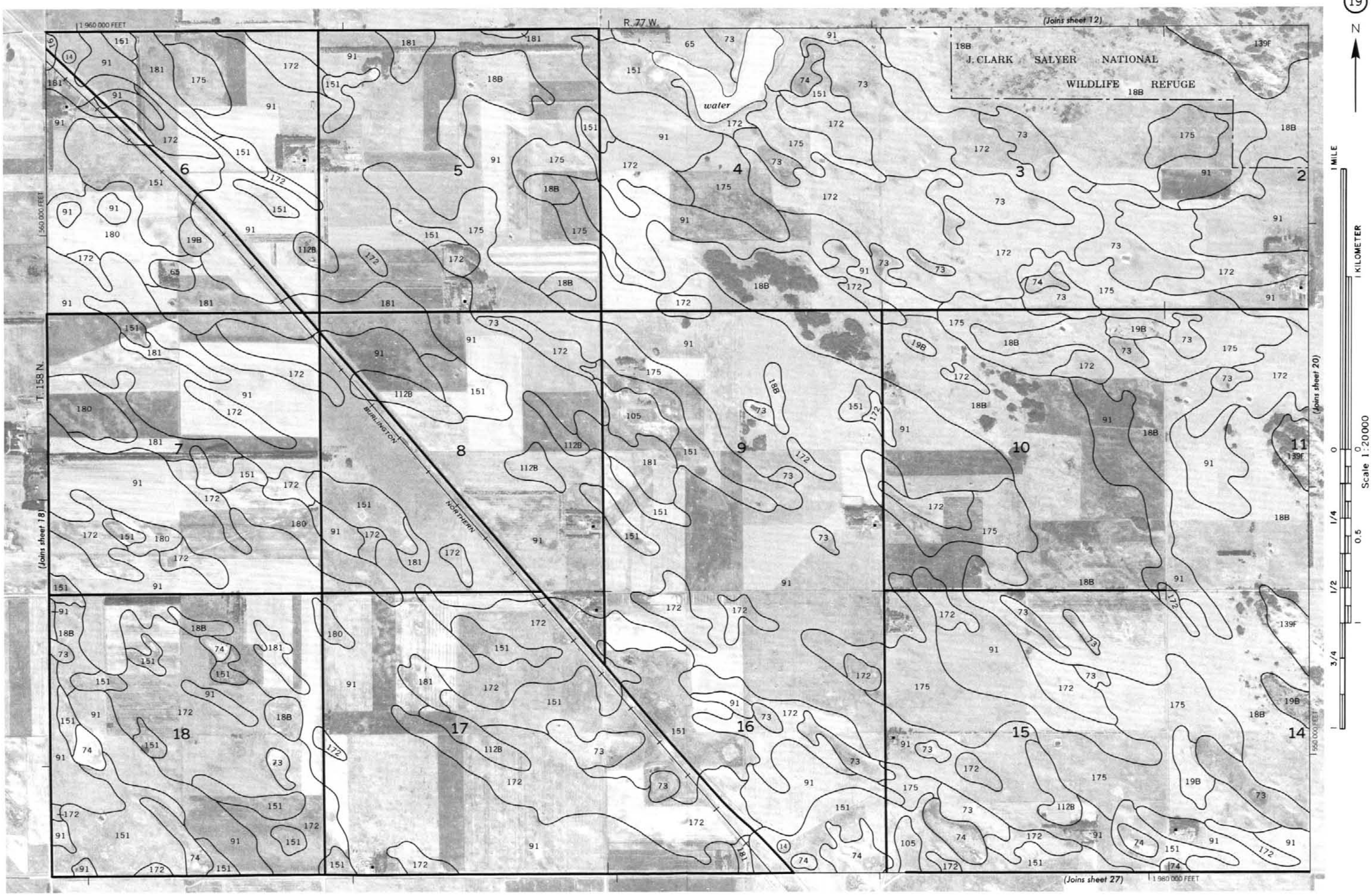
McHENRY COUNTY, NORTH DAKOTA NO. 17

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 18



McHENRY COUNTY, NORTH DAKOTA NO. 19

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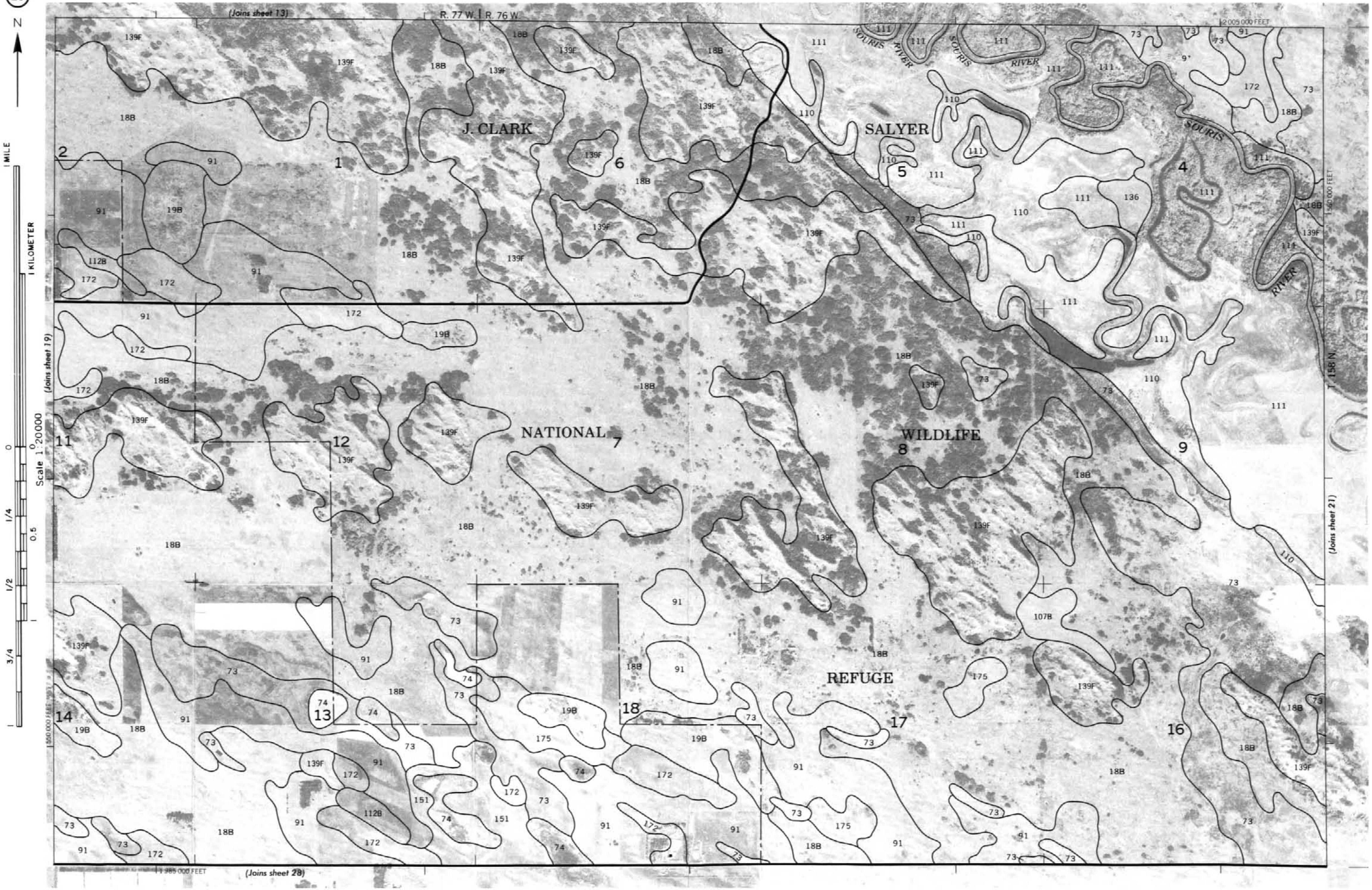

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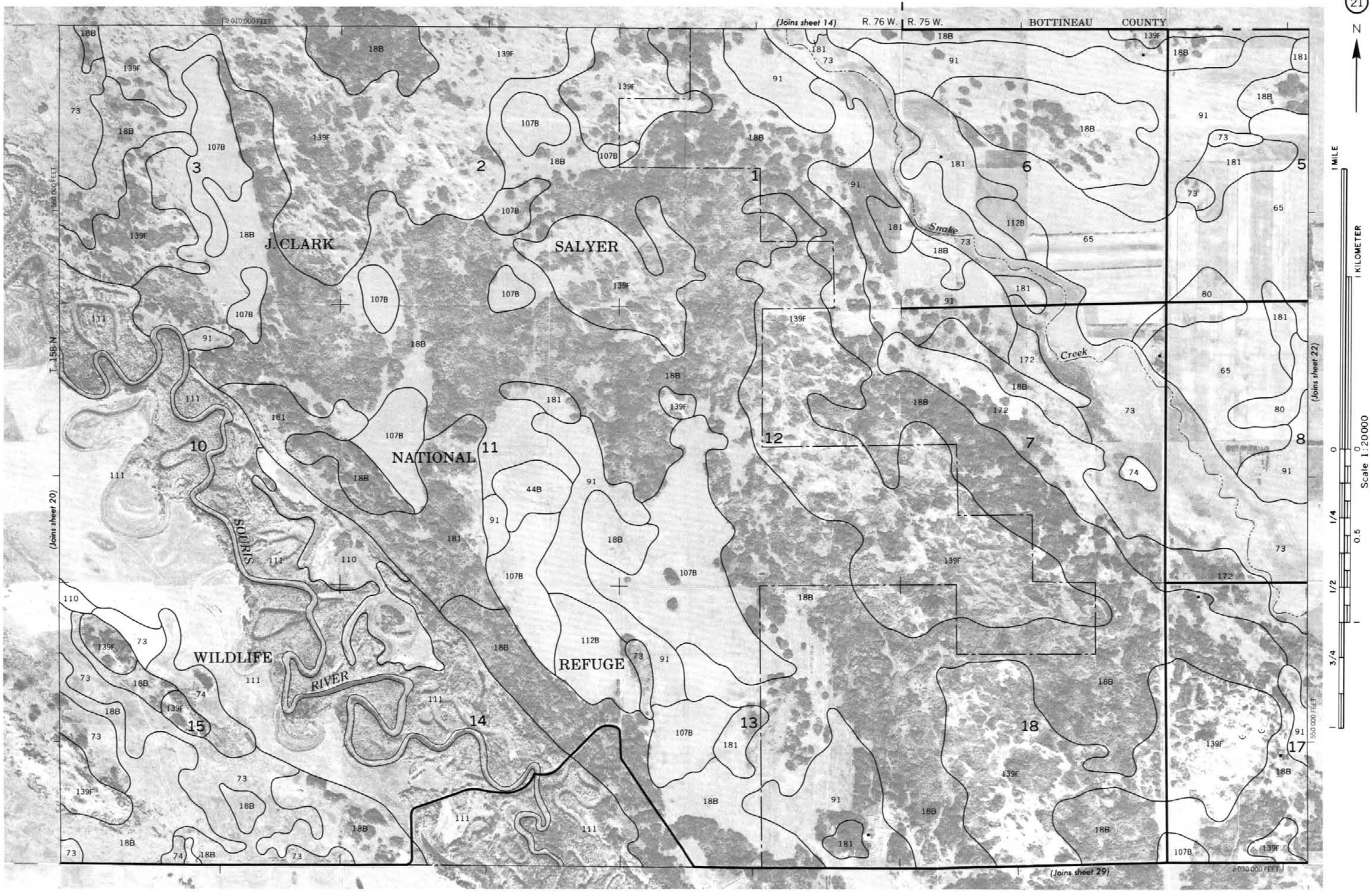
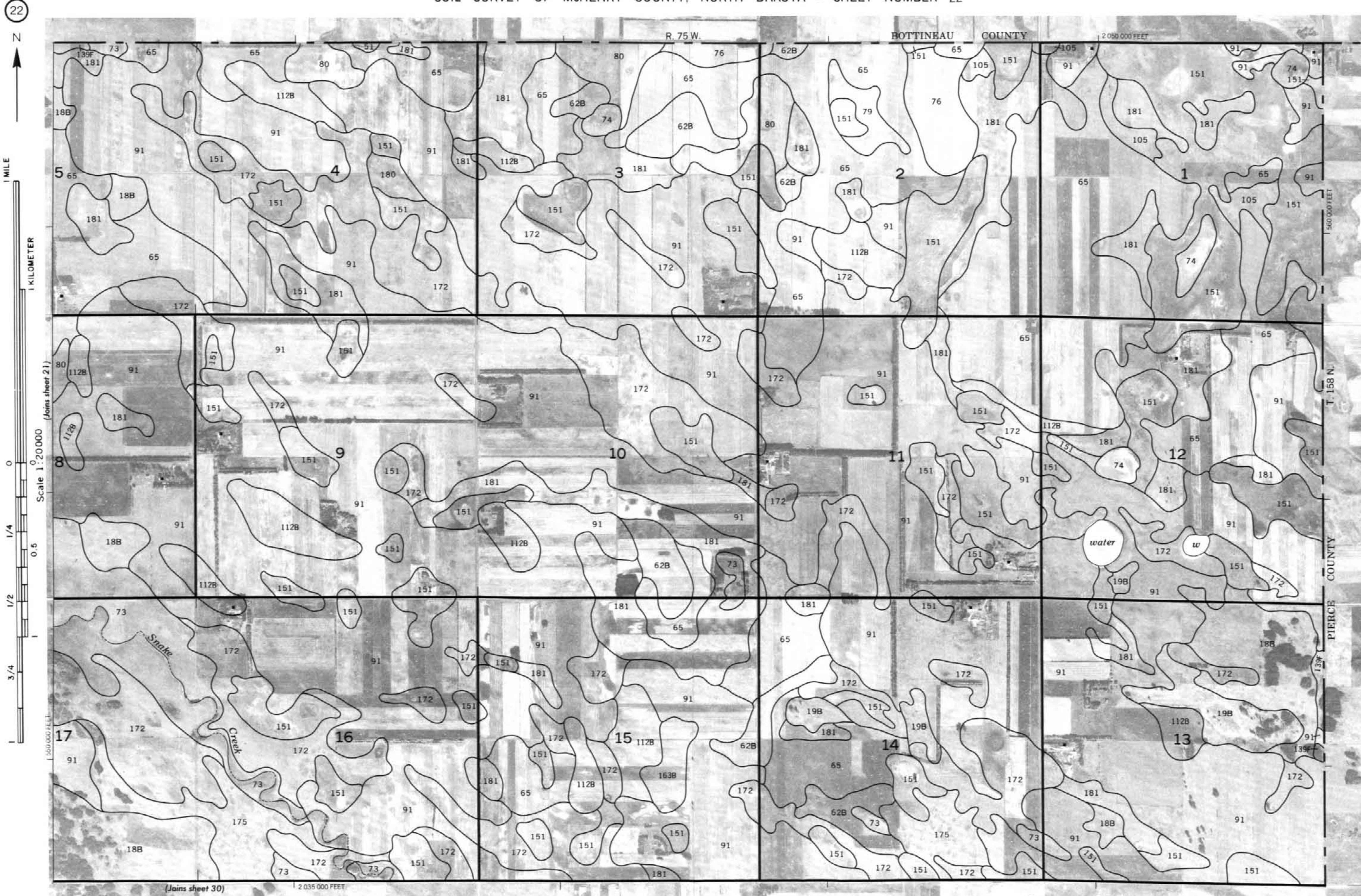
McHENRY COUNTY, NORTH DAKOTA NO. 20

(21)



McHENRY COUNTY, NORTH DAKOTA NO. 21

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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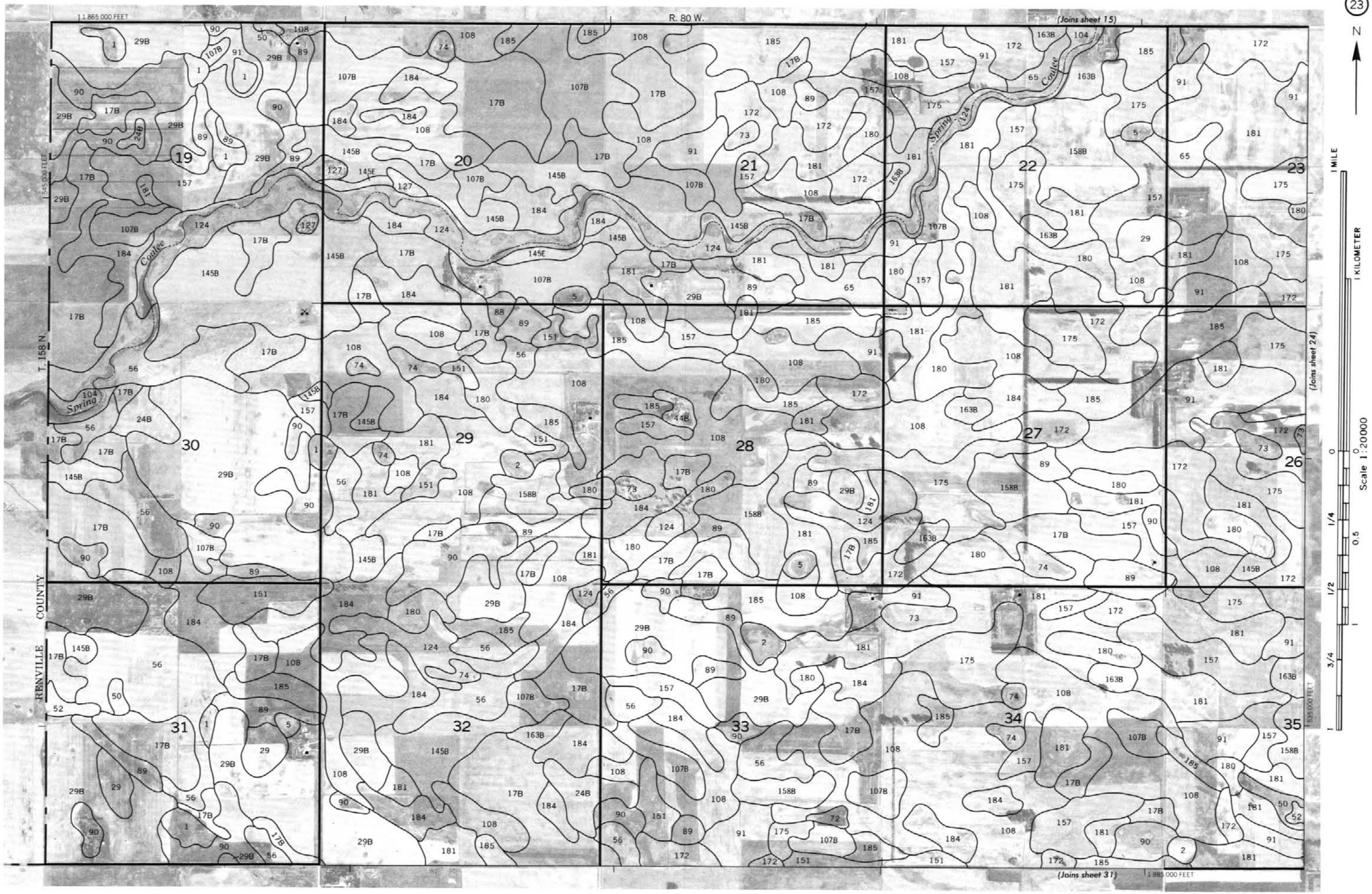
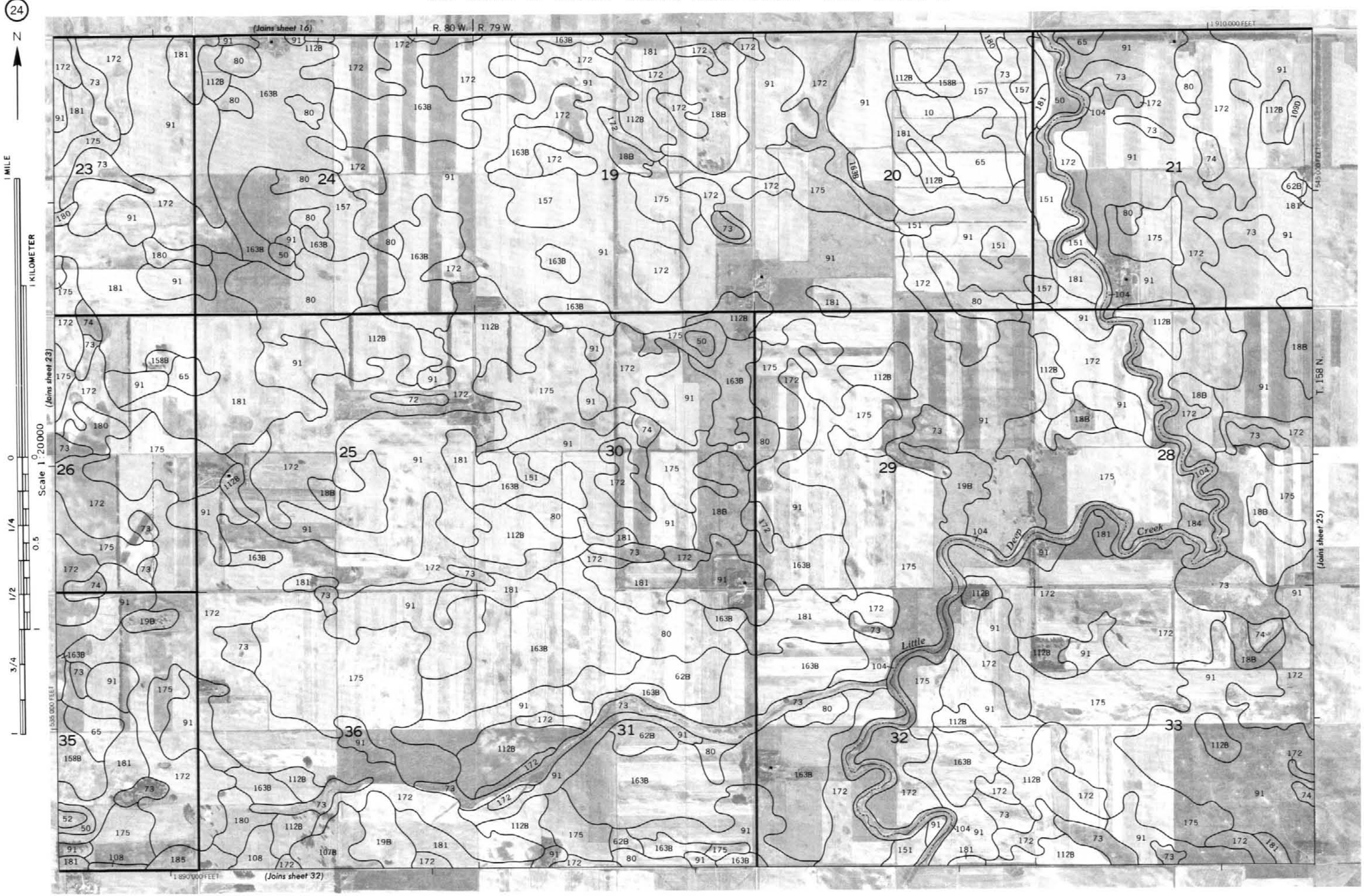
McHENRY COUNTY, NORTH DAKOTA NO. 22



McHENRY COUNTY, NORTH DAKOTA NO. 23

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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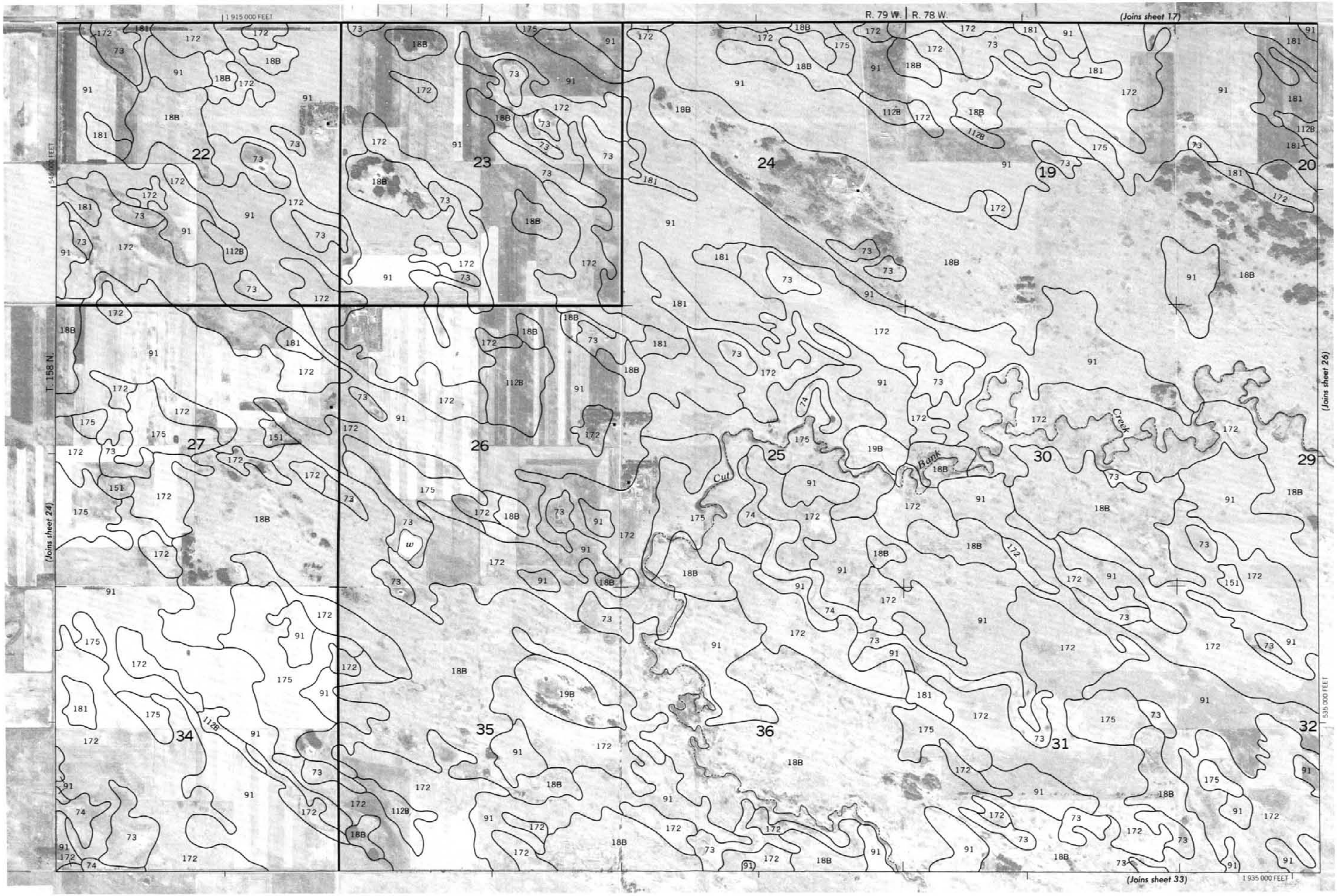
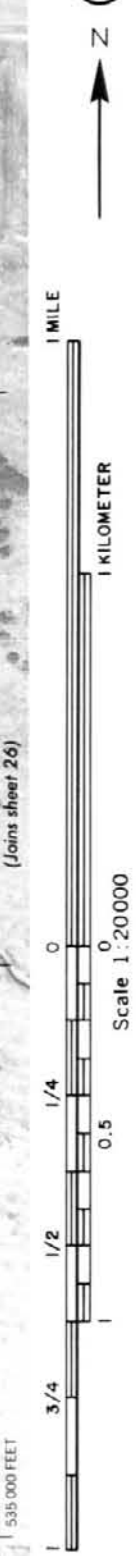
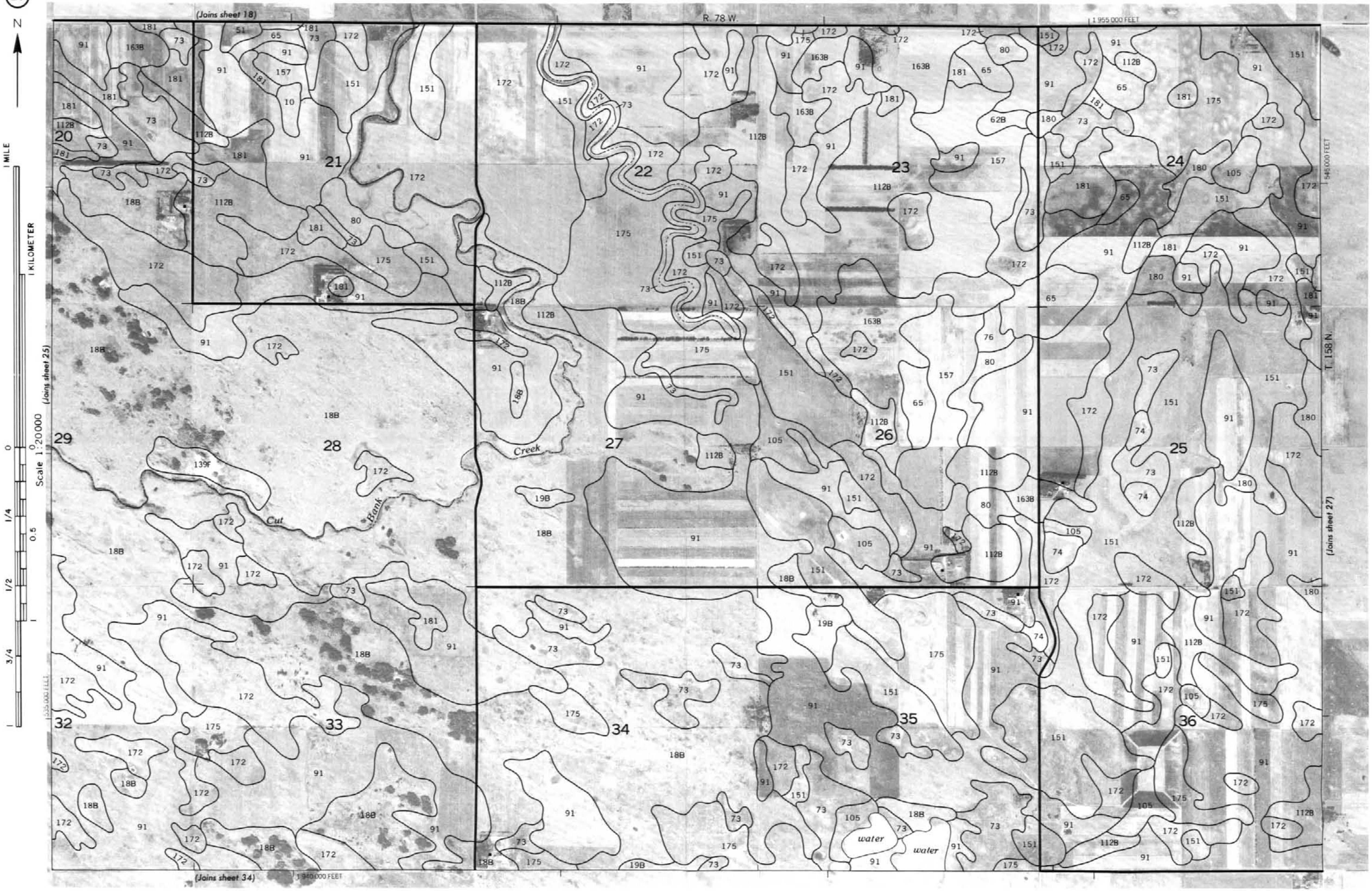




McHENRY COUNTY, NORTH DAKOTA NO. 25

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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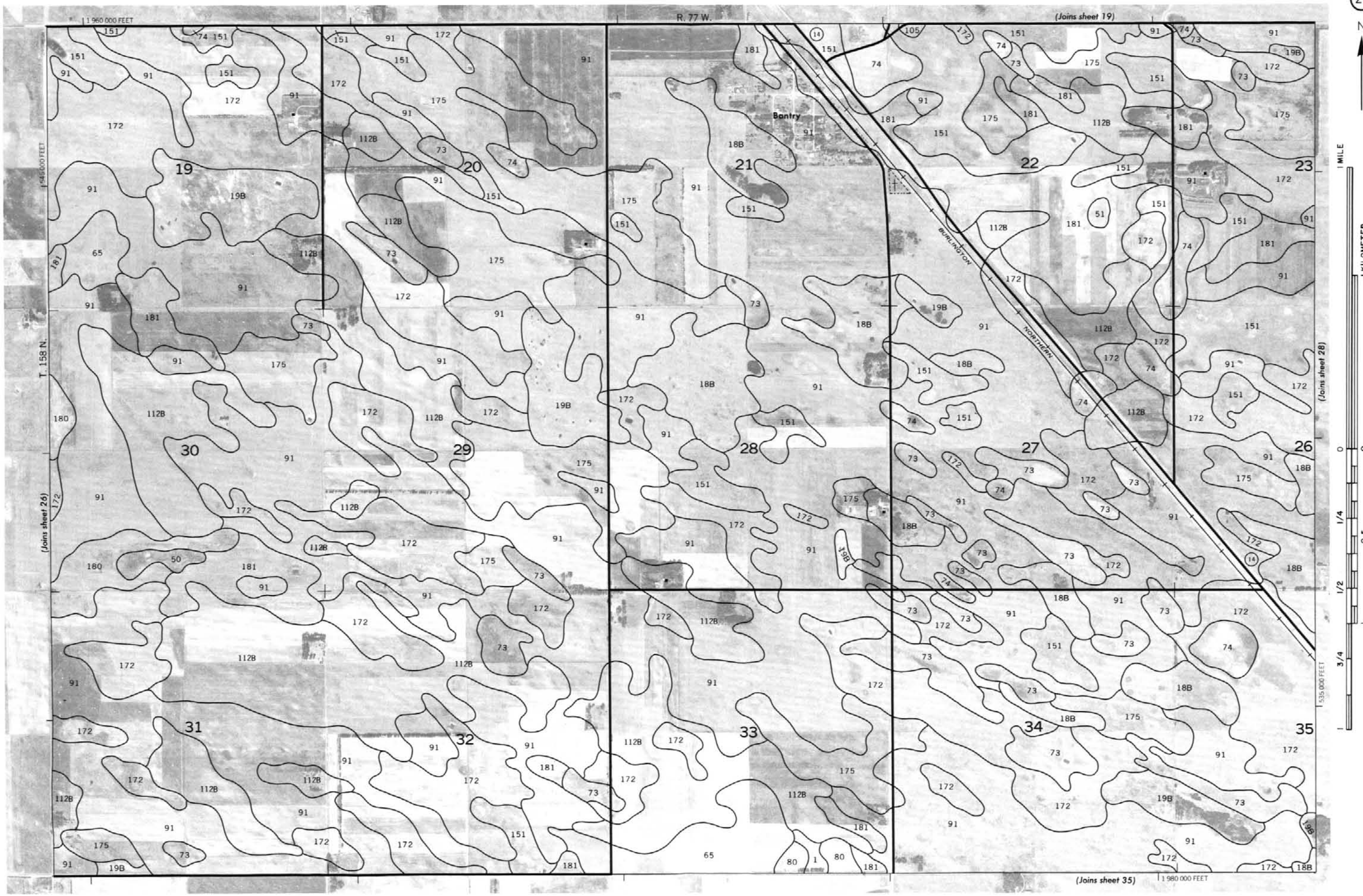
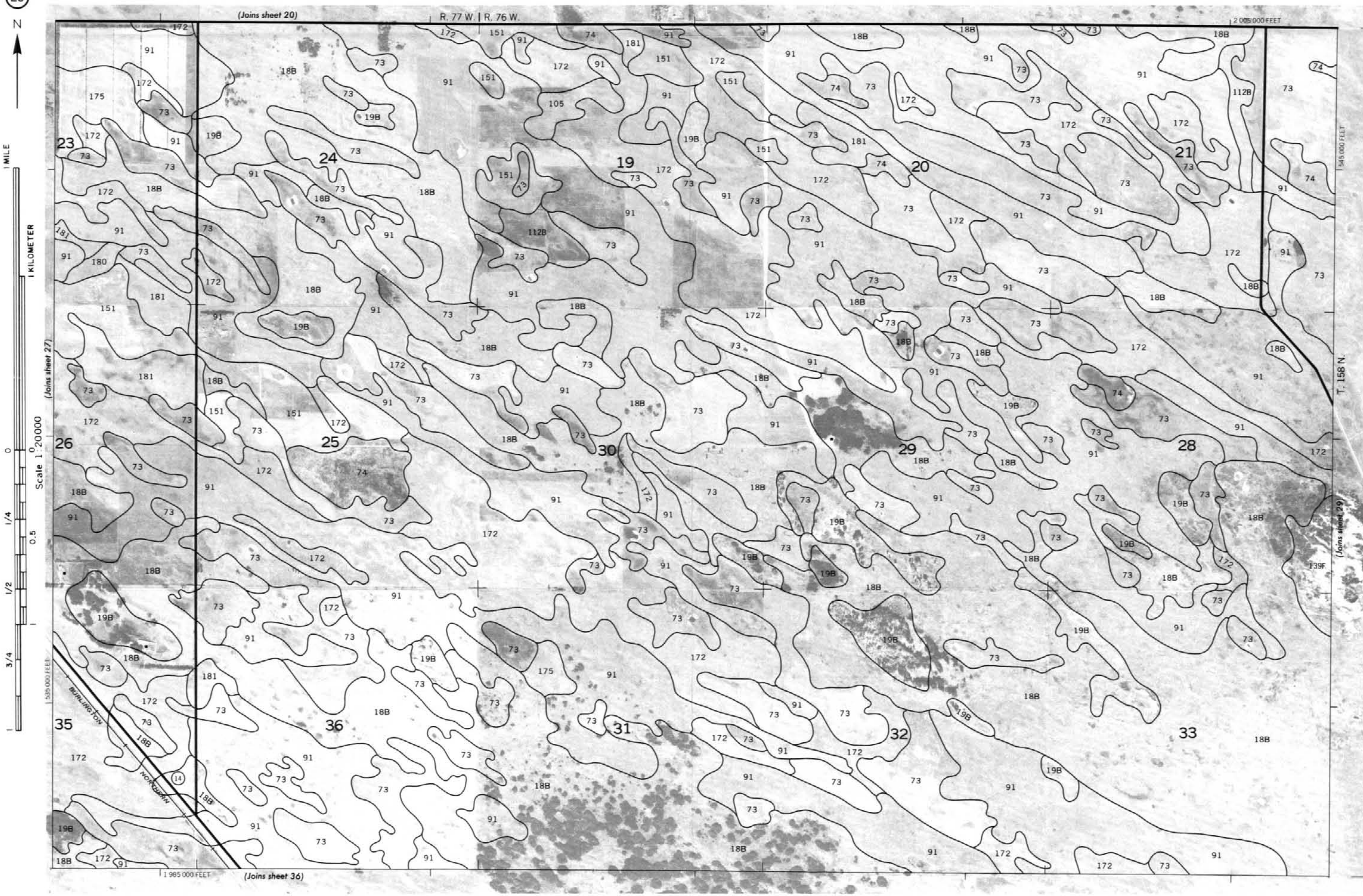


McHENRY COUNTY, NORTH DAKOTA NO. 27

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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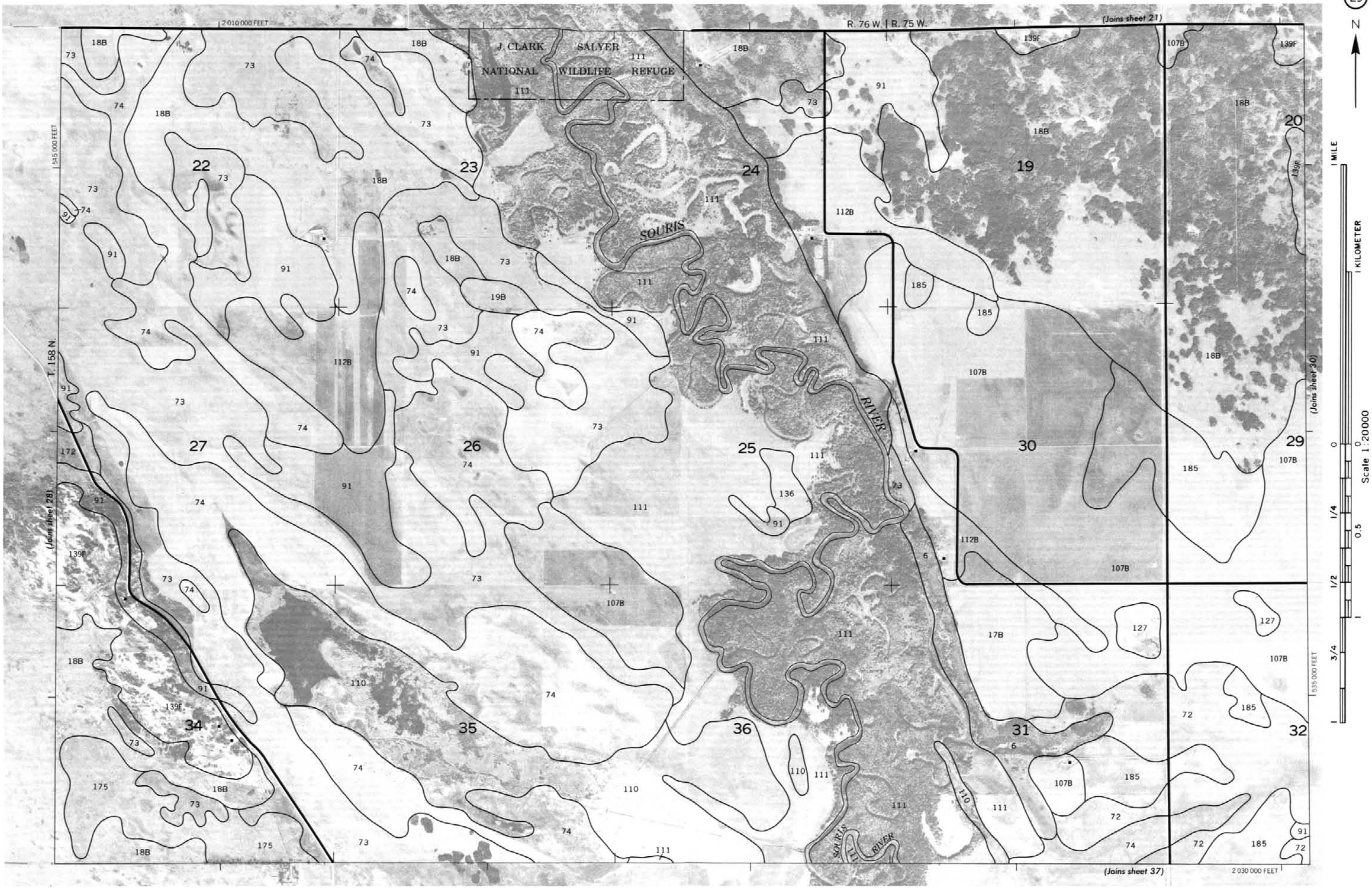

McHENRY COUNTY, NORTH DAKOTA NO. 29

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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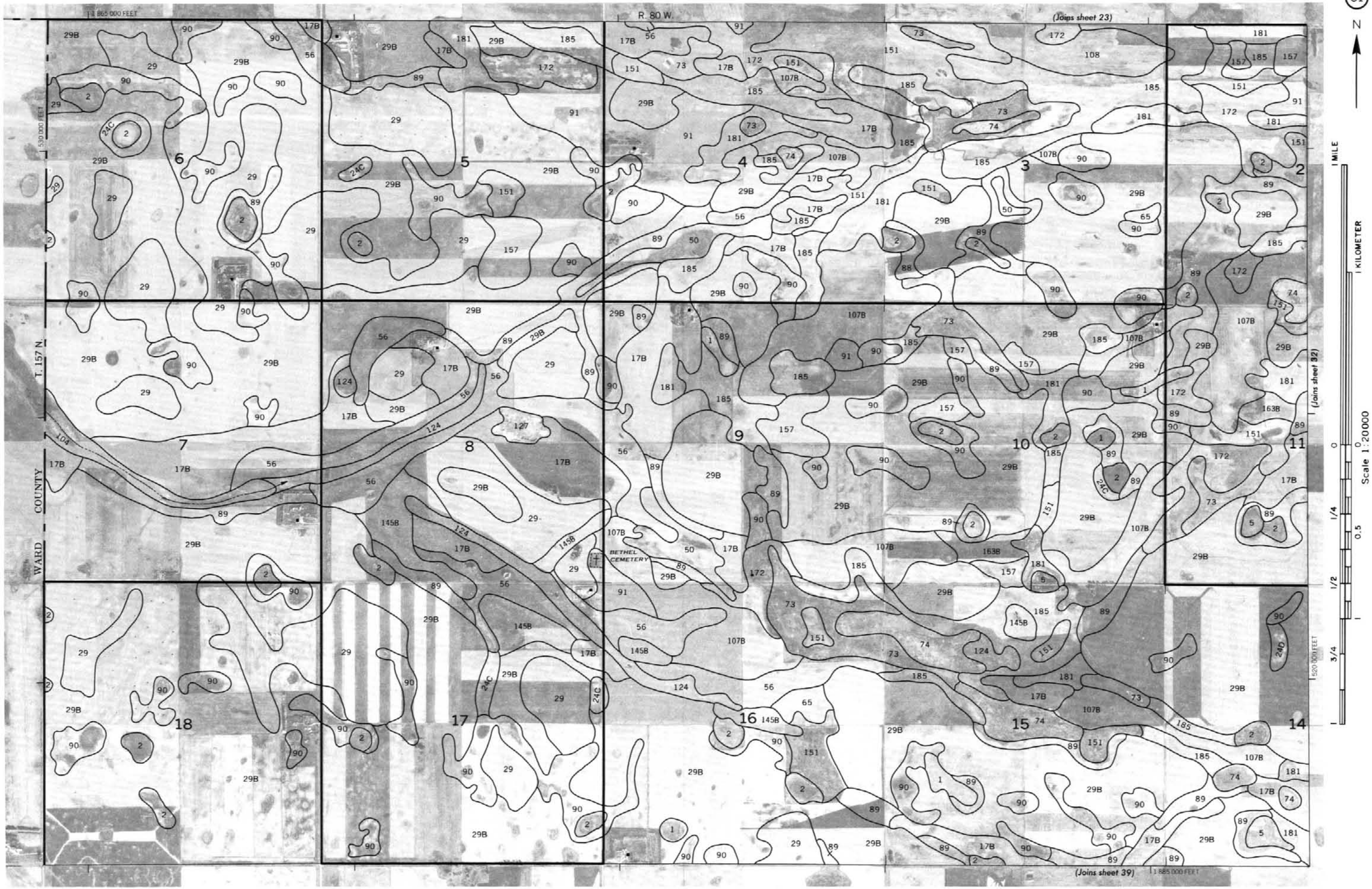
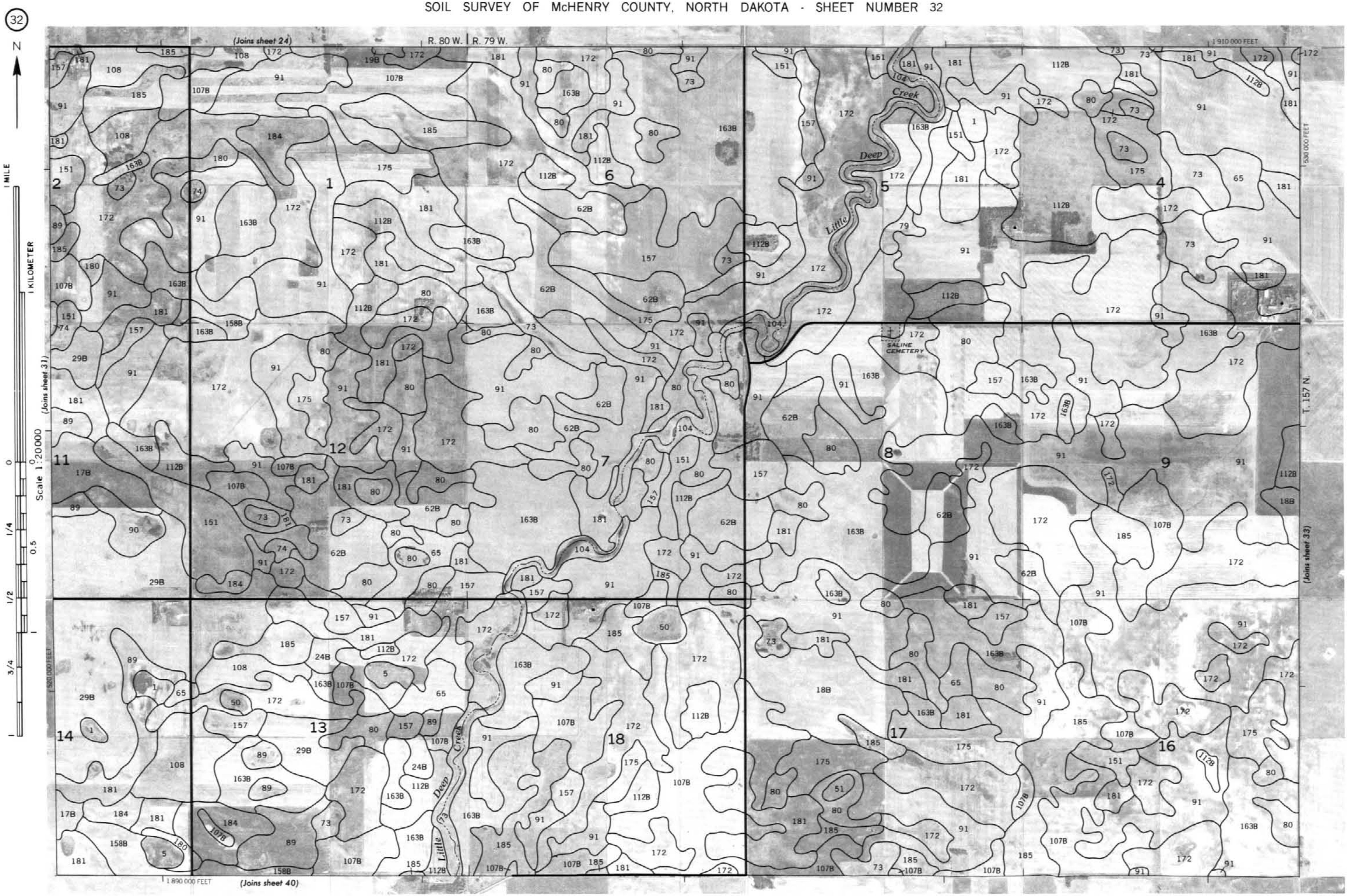
31



McHENRY COUNTY, NORTH DAKOTA NO. 31

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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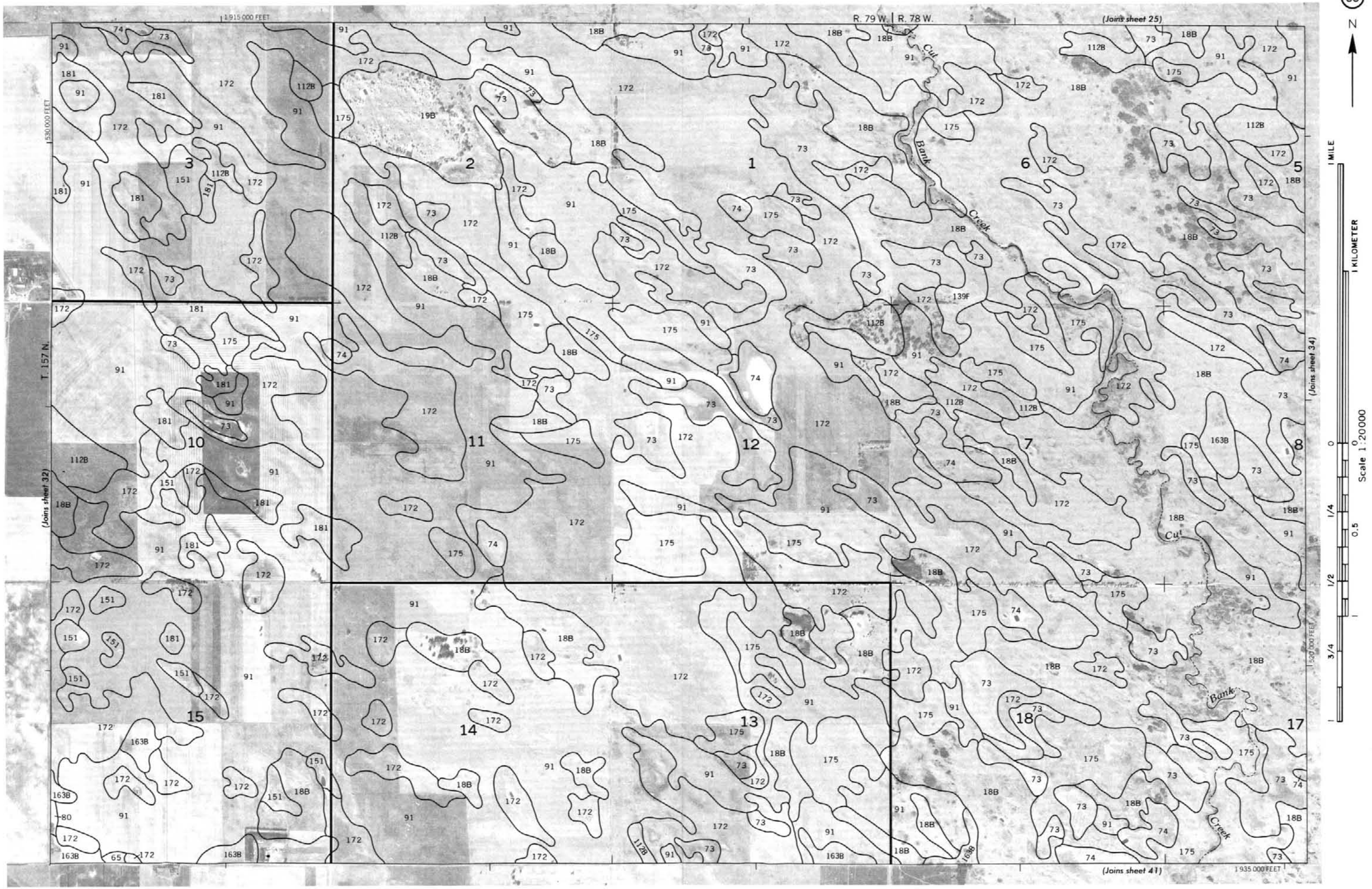

McHENRY COUNTY, NORTH DAKOTA NO. 33

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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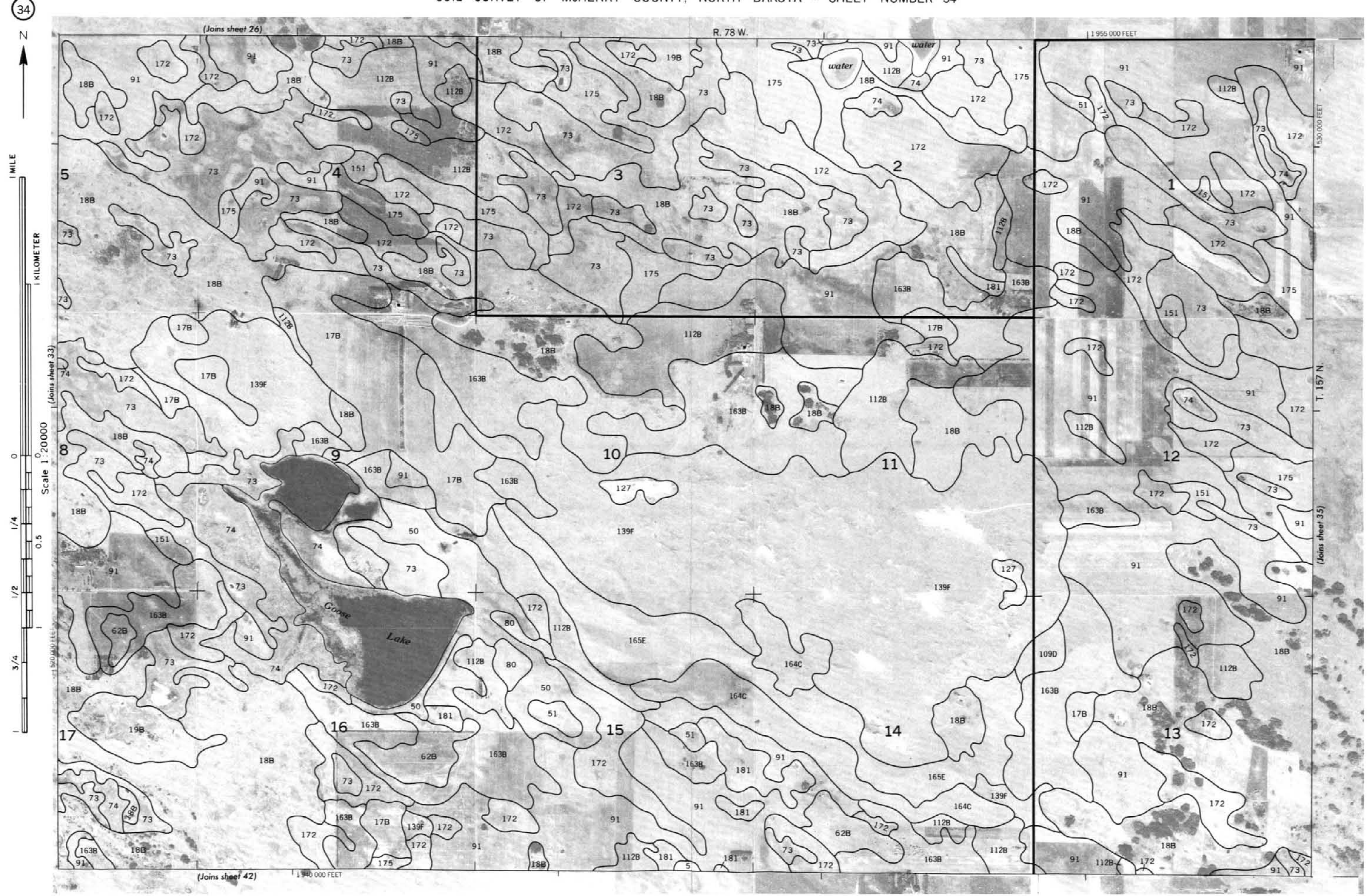

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McHENRY COUNTY, NORTH DAKOTA NO. 35

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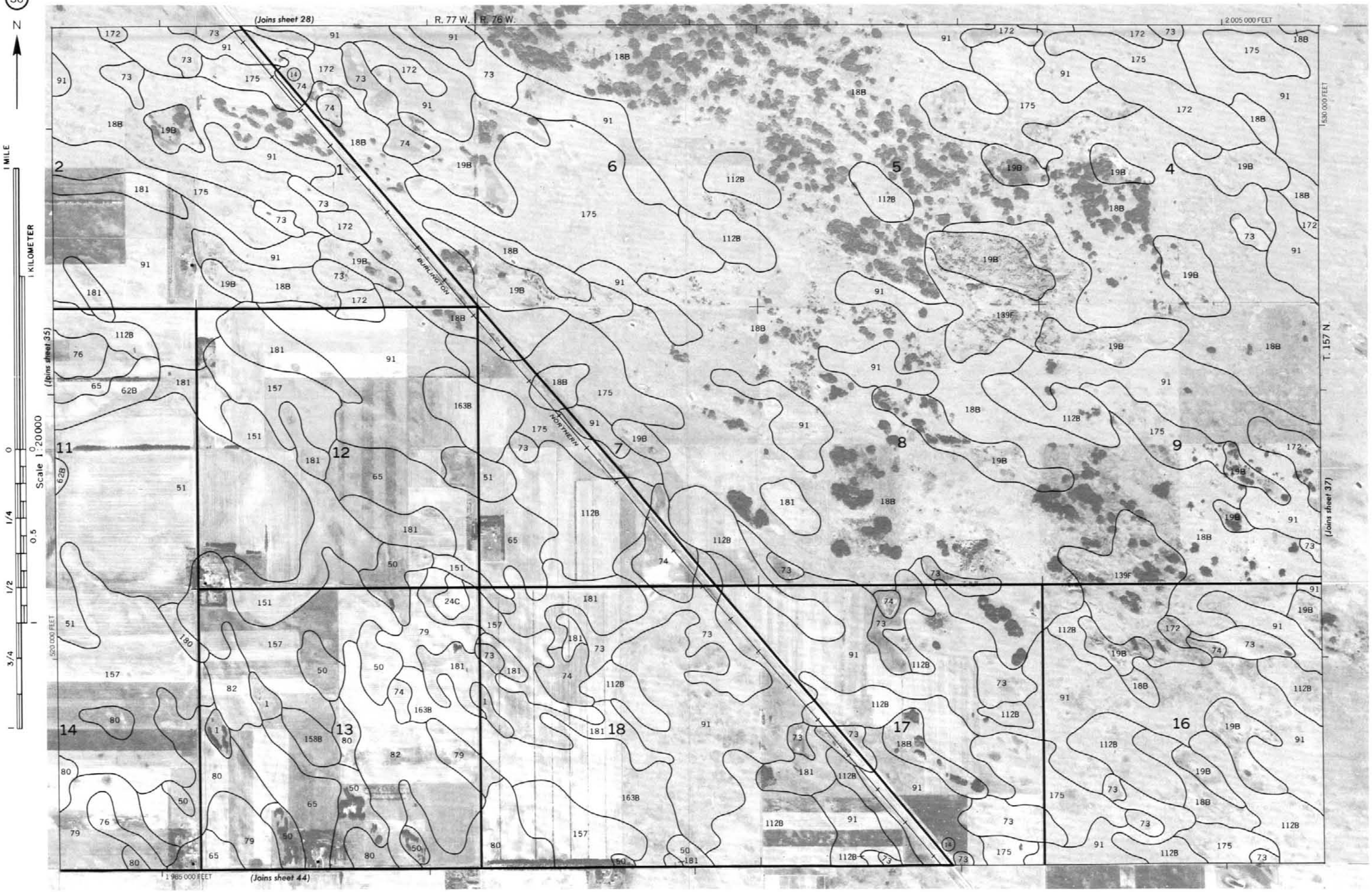

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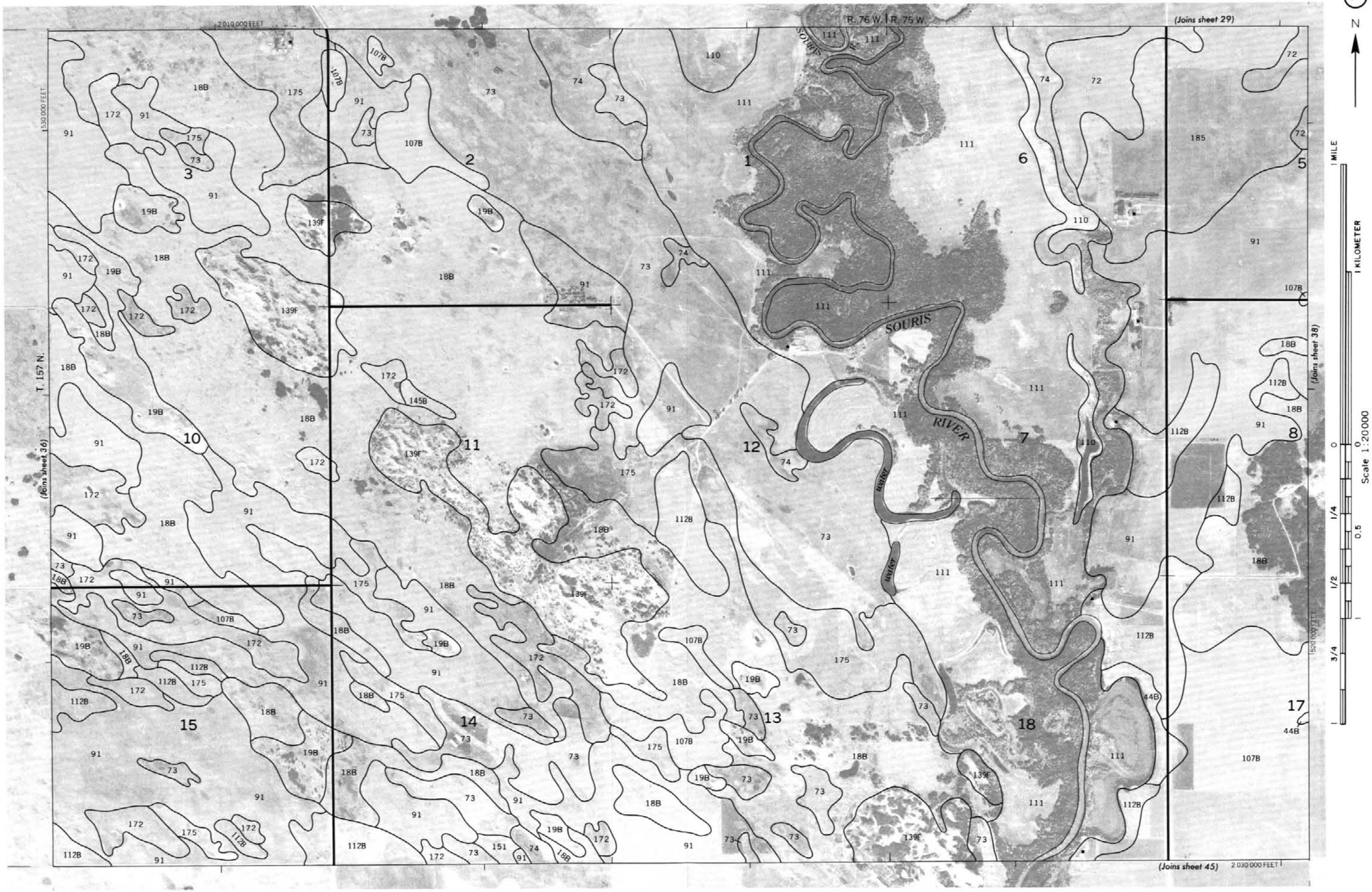
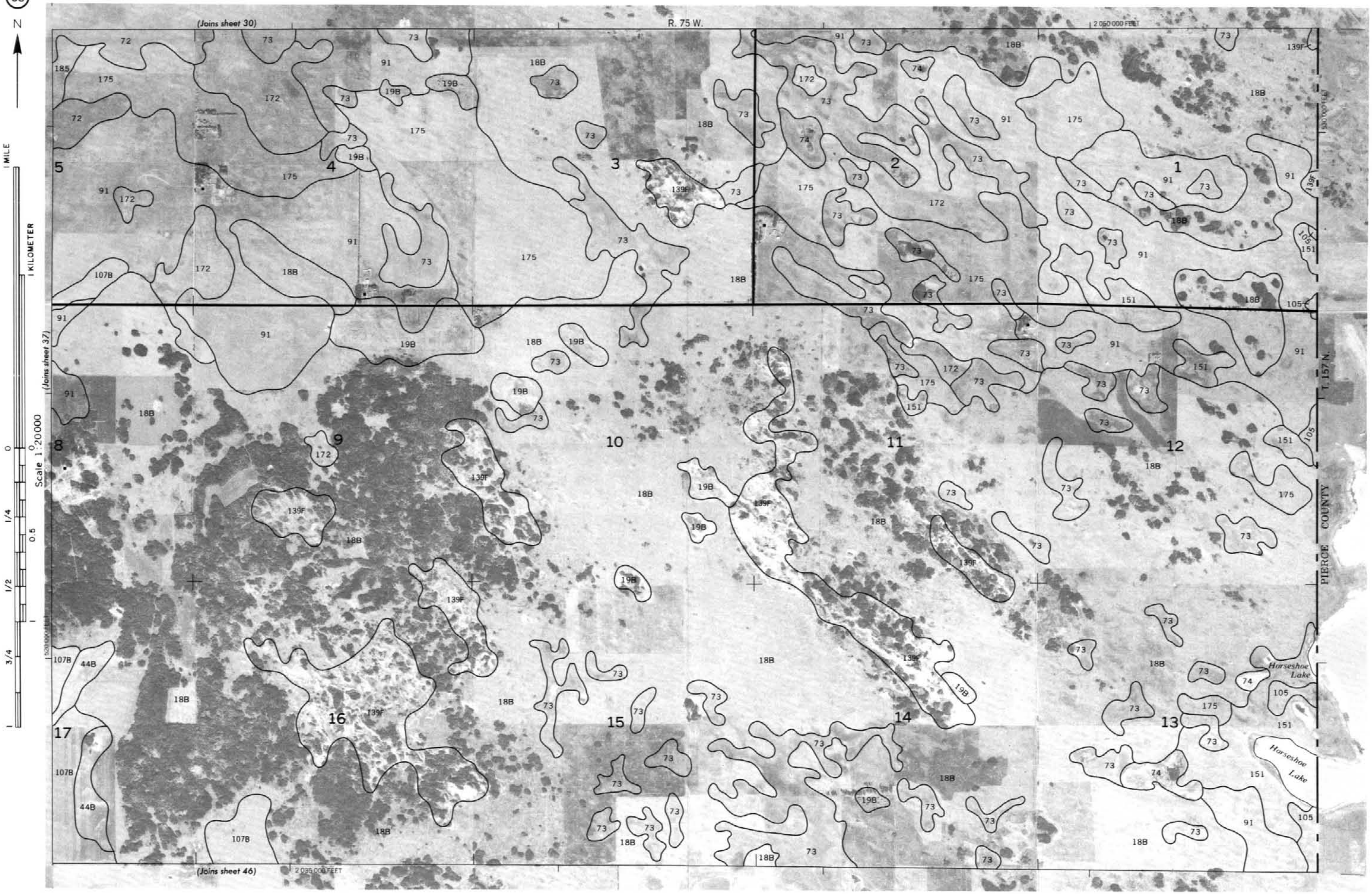


McHENRY COUNTY, NORTH DAKOTA NO. 37

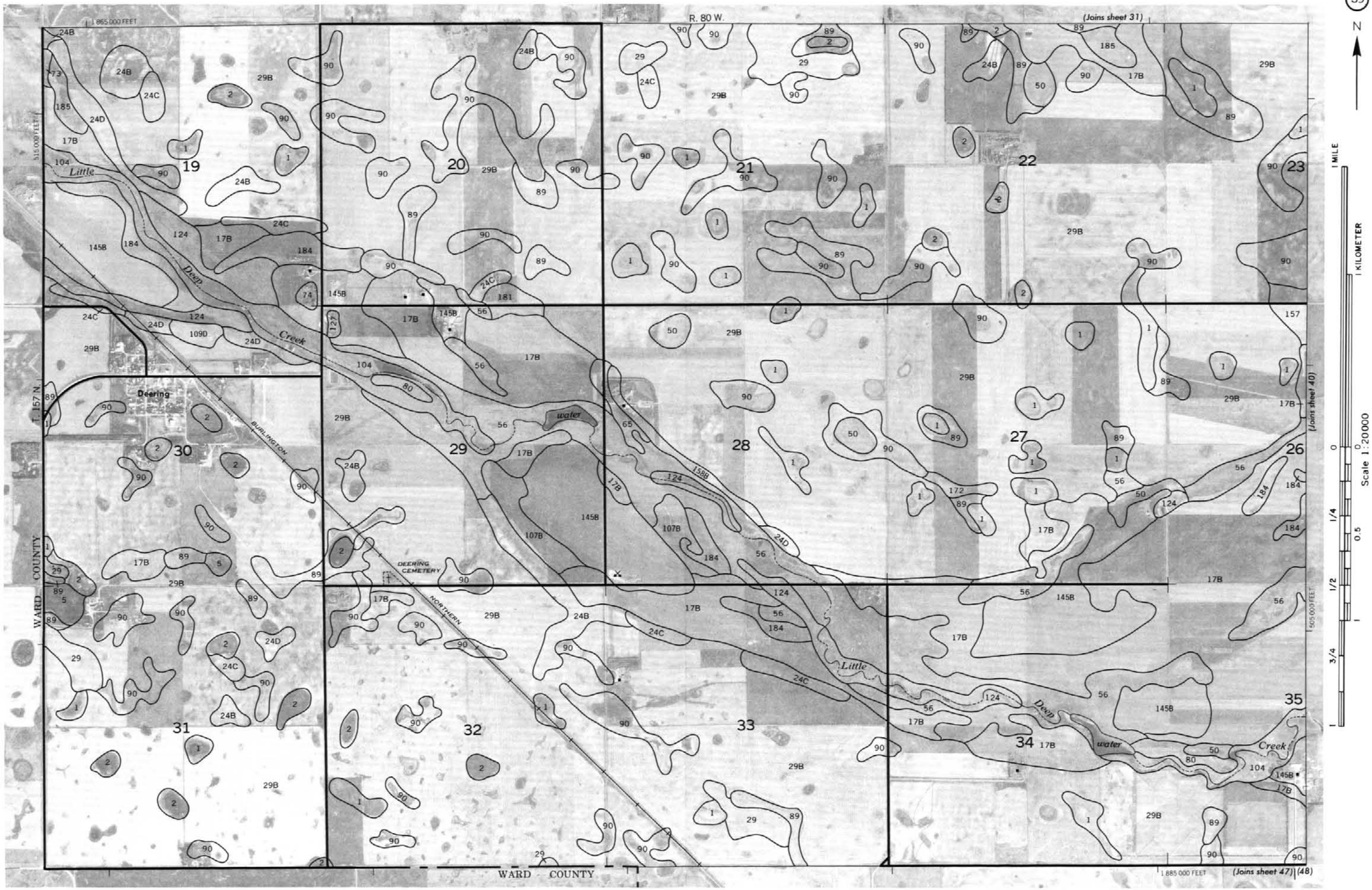
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 38

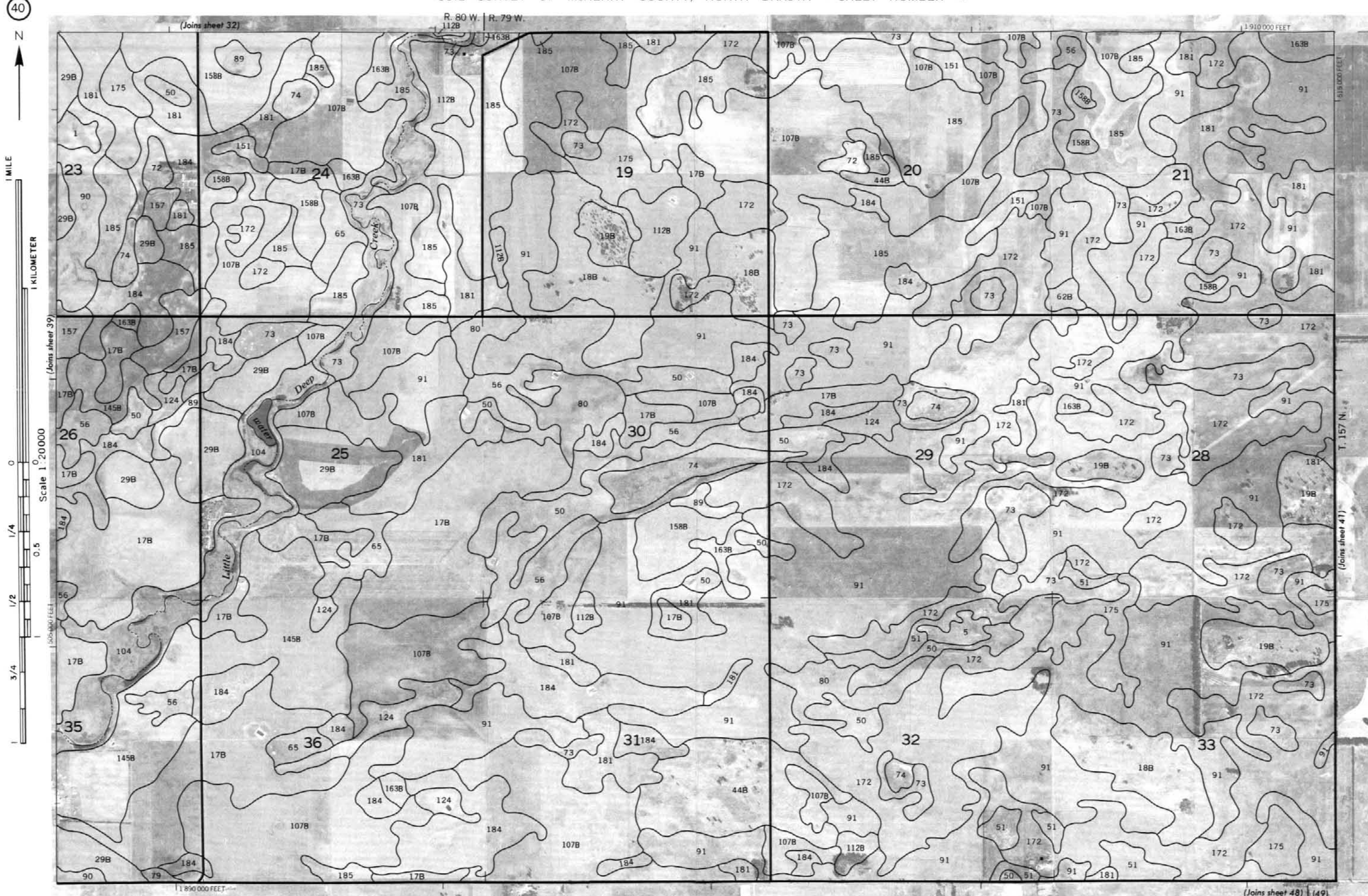


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 38

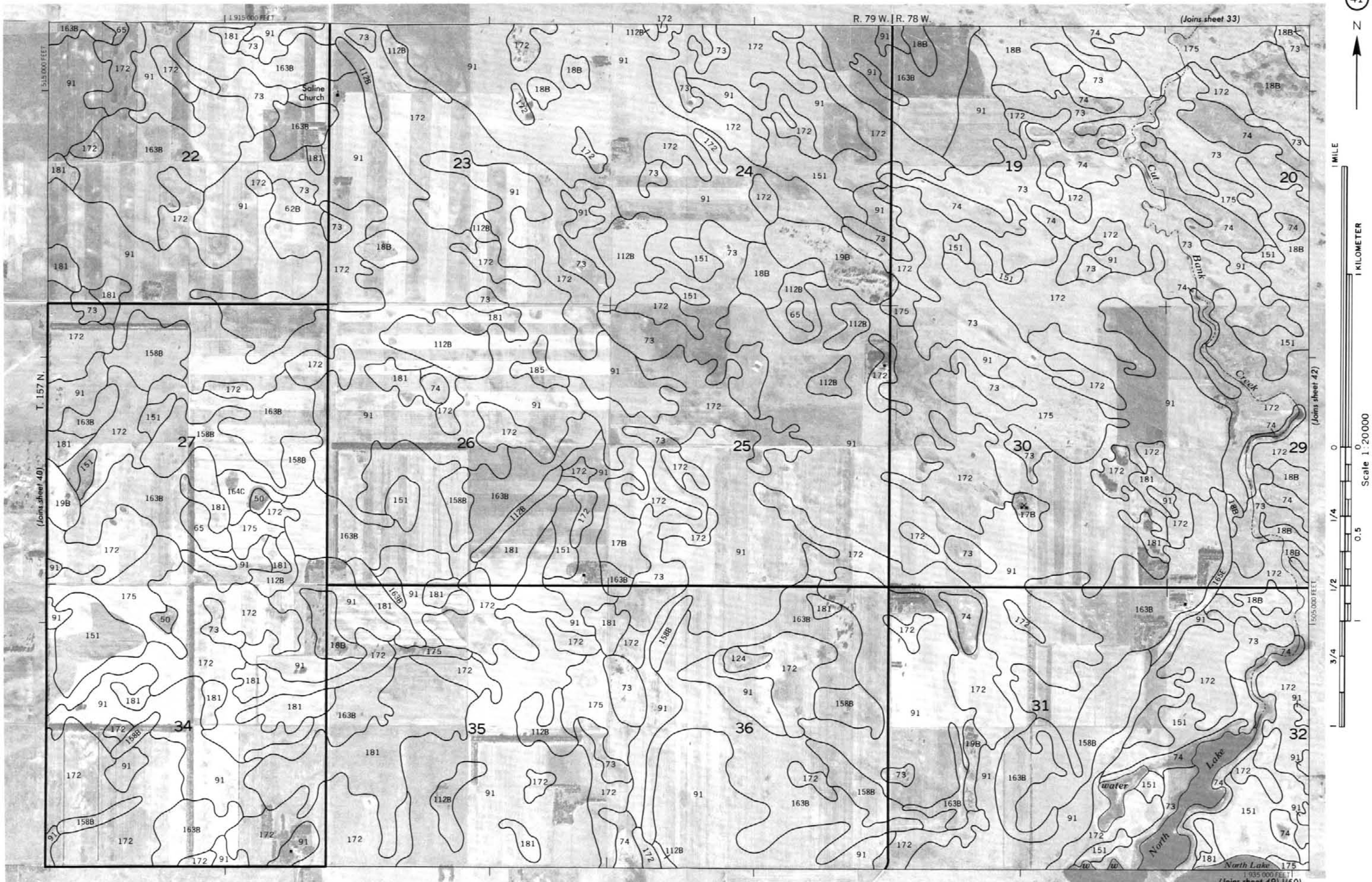


McHENRY COUNTY, NORTH DAKOTA NO. 39



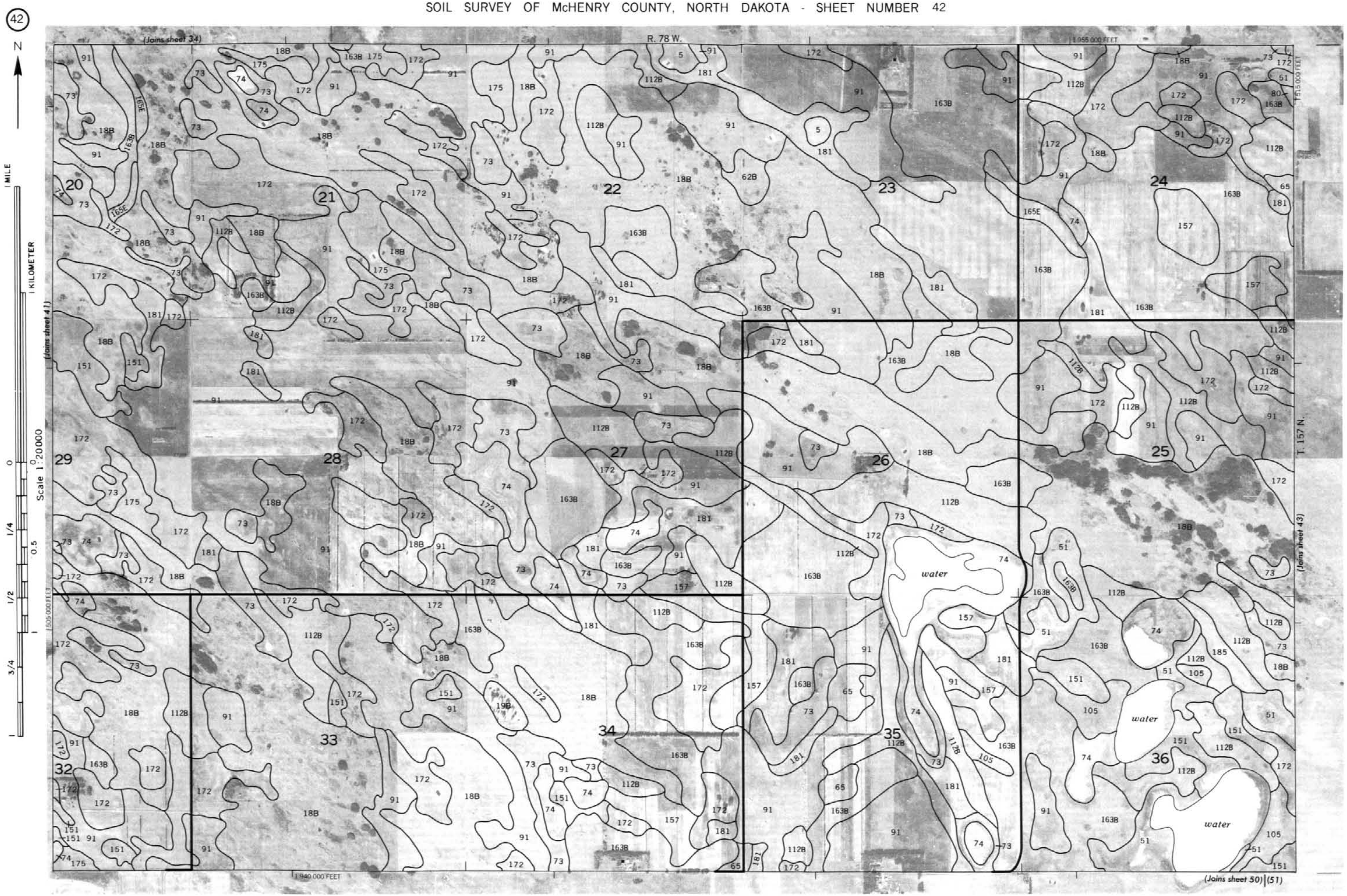
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 40



McHENRY COUNTY, NORTH DAKOTA NO. 41

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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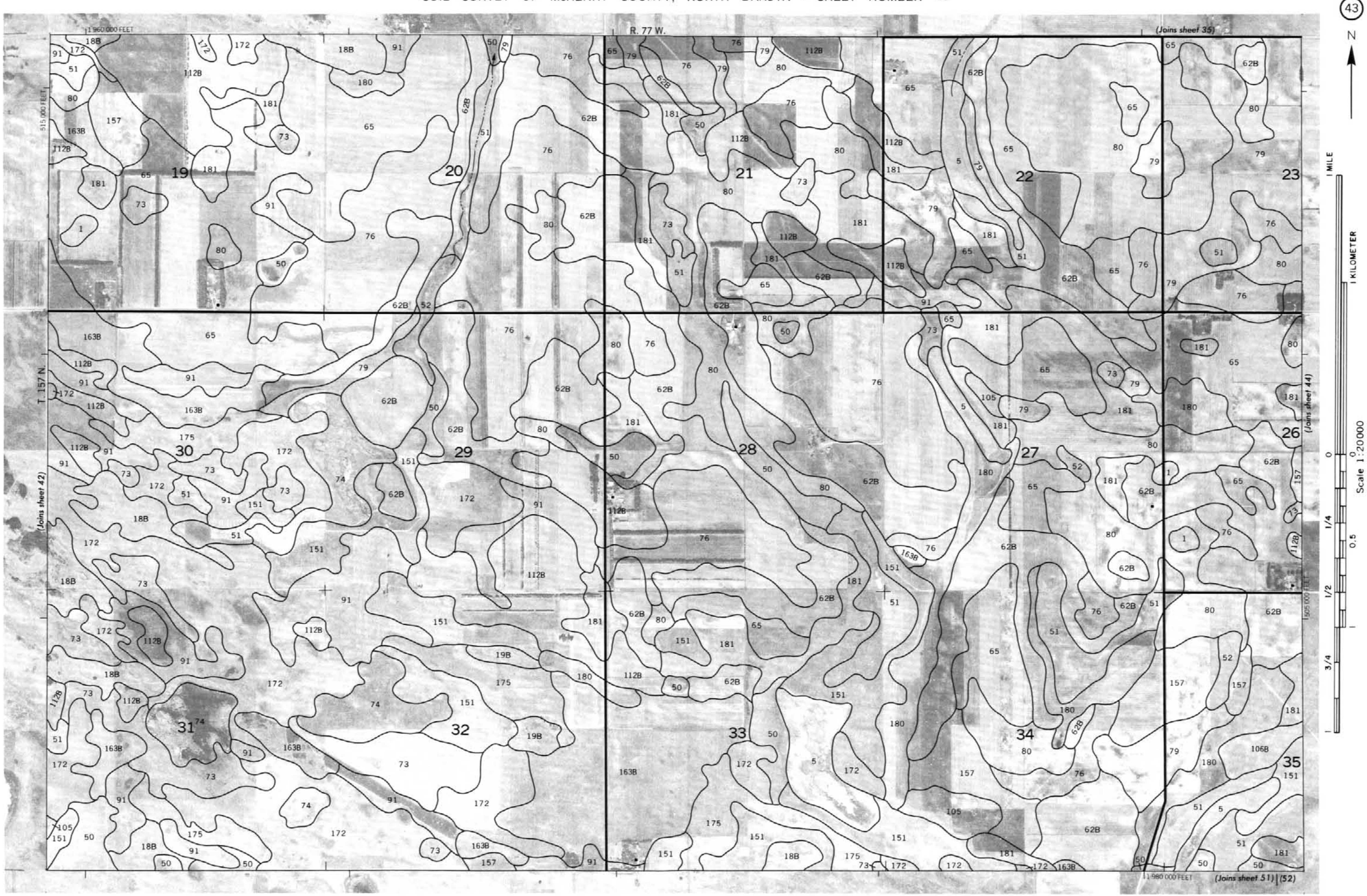
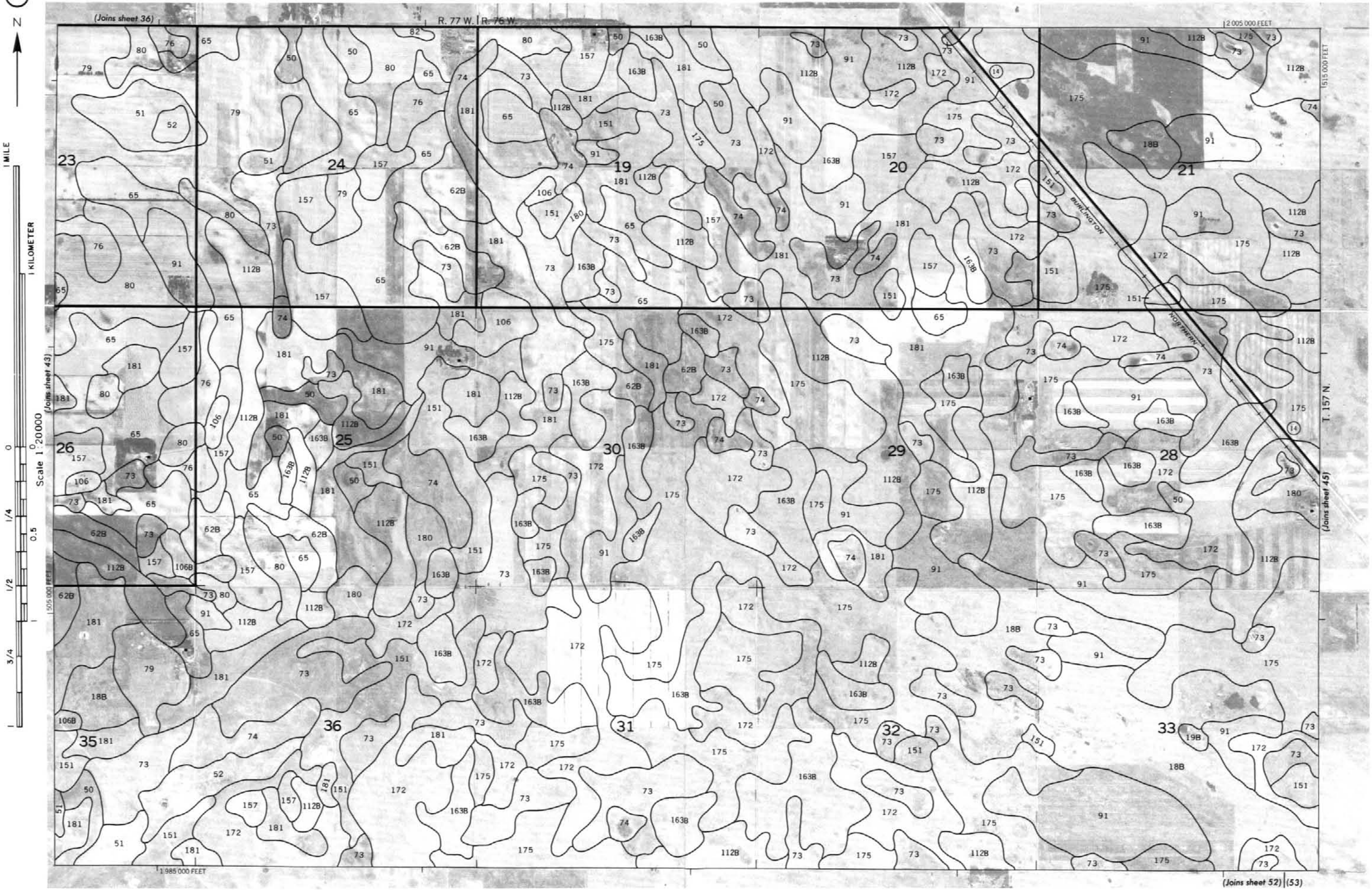


McHENRY COUNTY, NORTH DAKOTA NO. 43

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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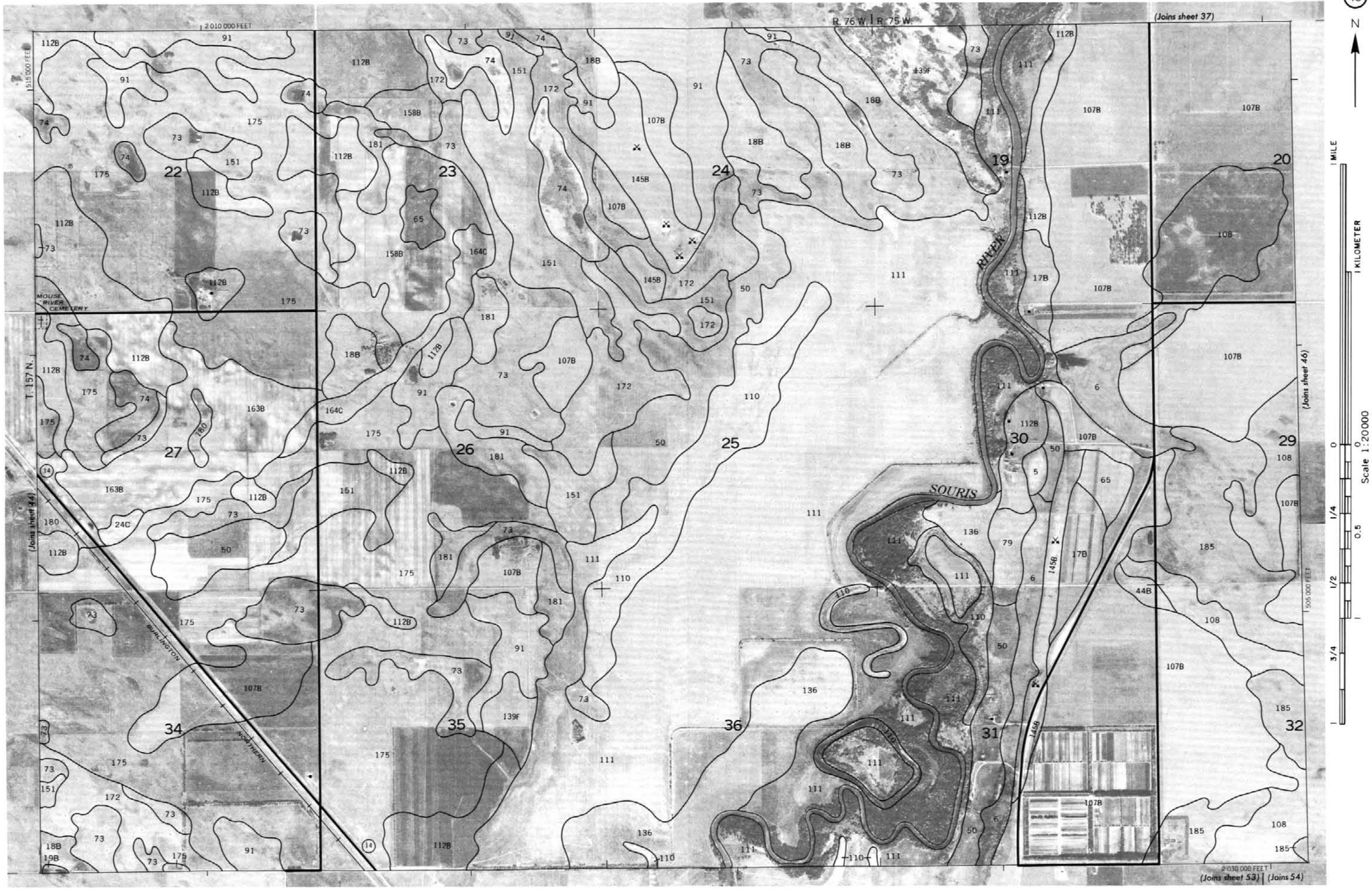
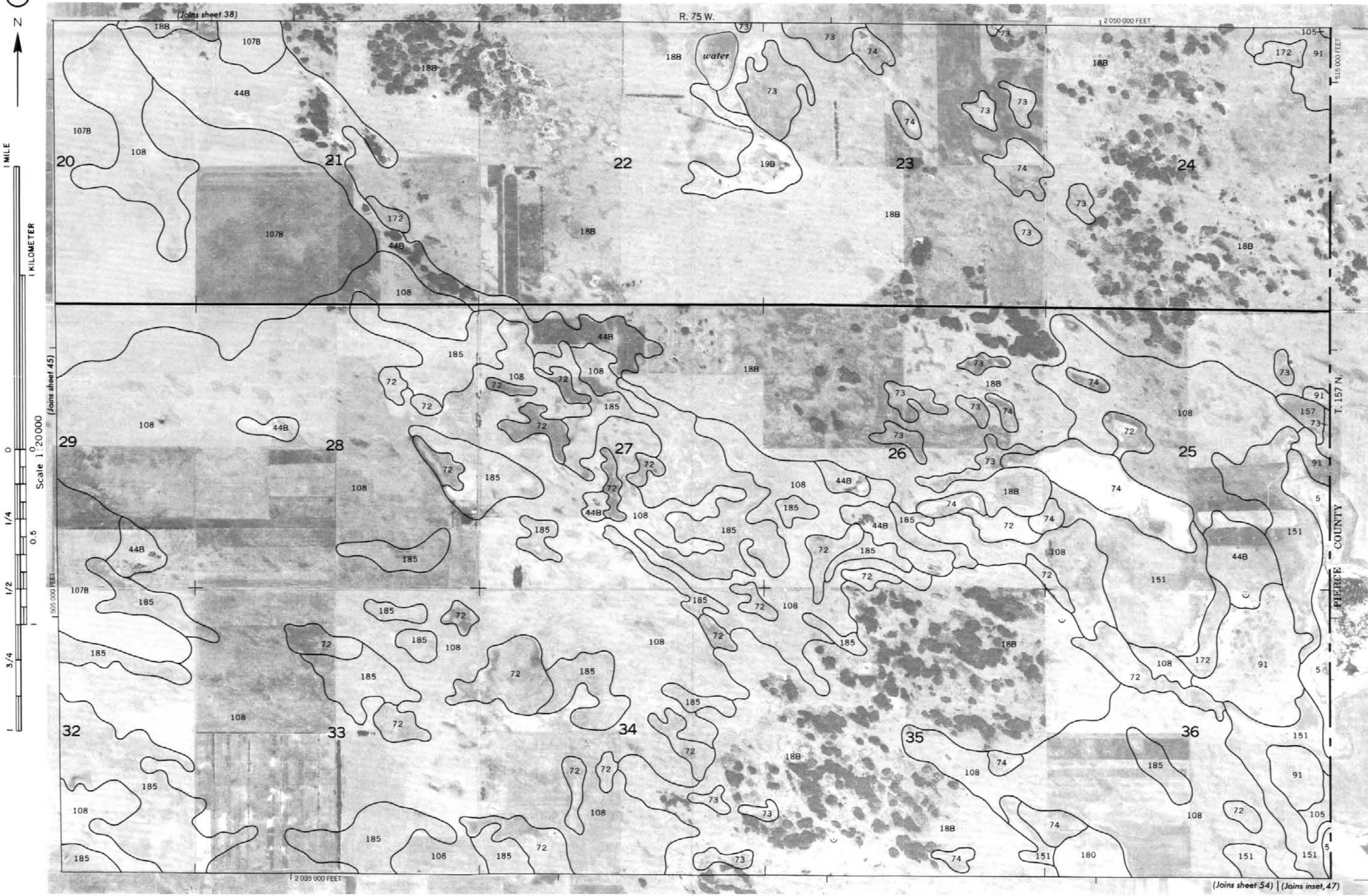


McHENRY COUNTY, NORTH DAKOTA NO. 45

This soil survey map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 46

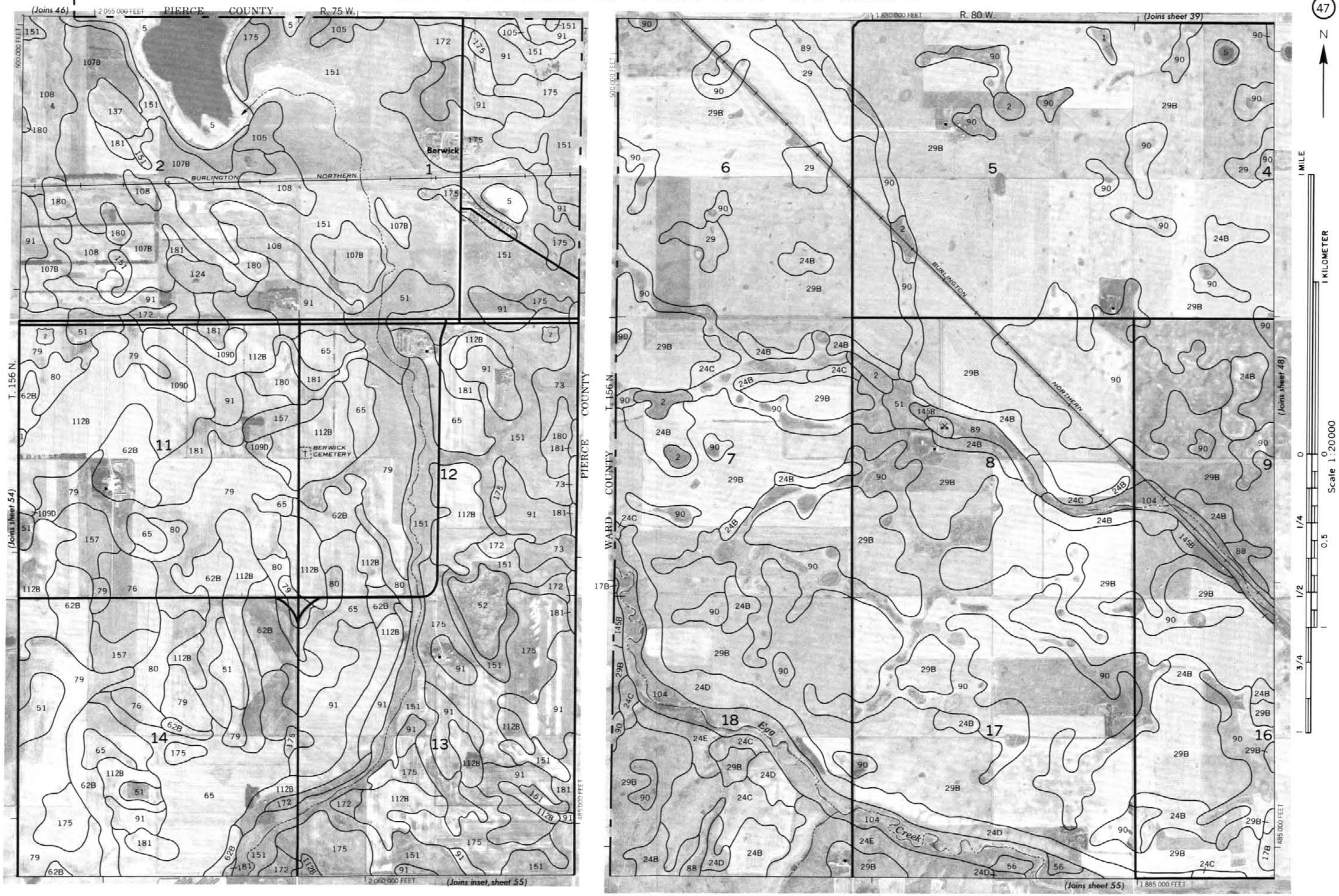


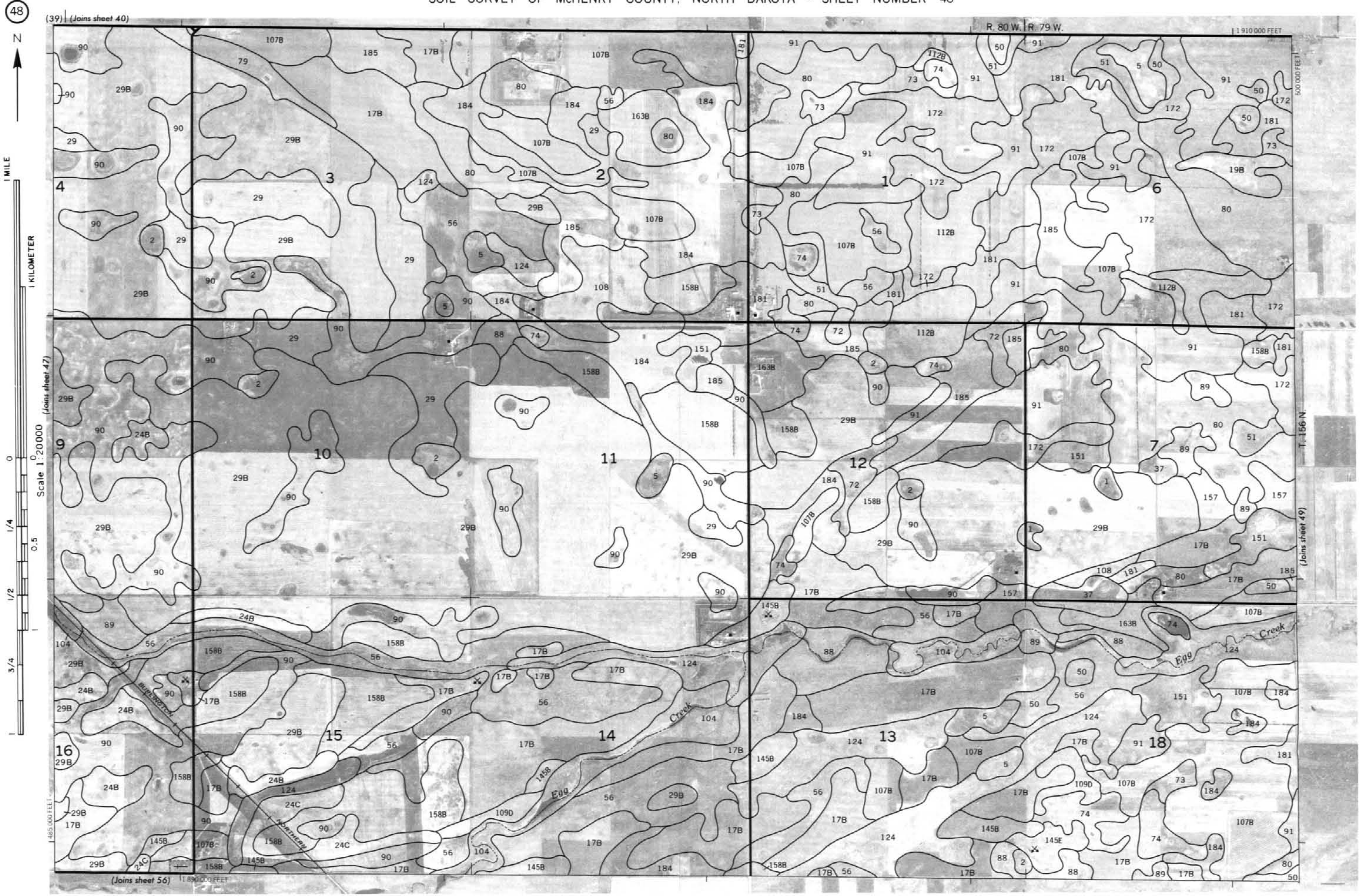
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 46

McHENRY COUNTY, NORTH DAKOTA NO. 47

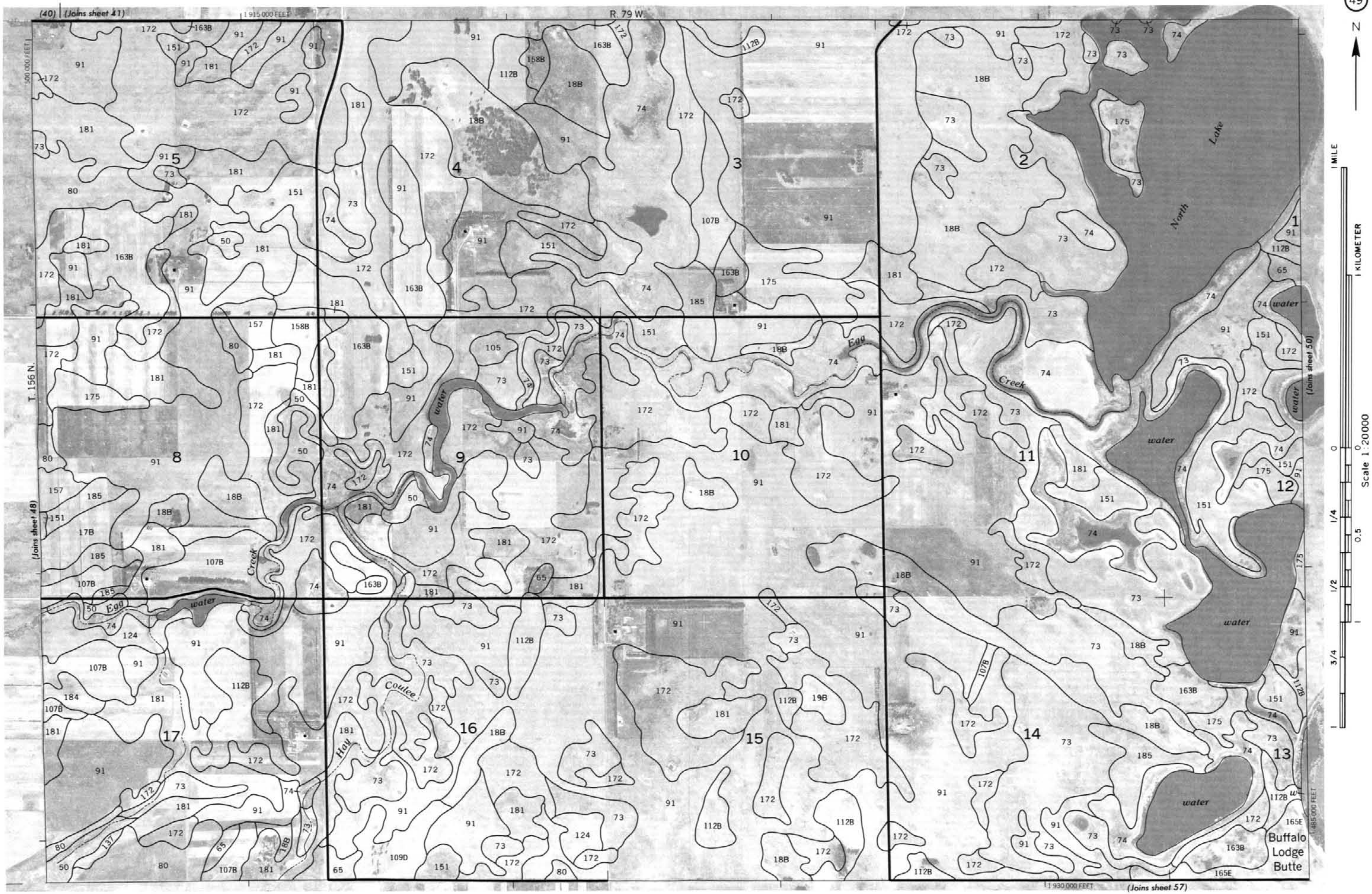
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





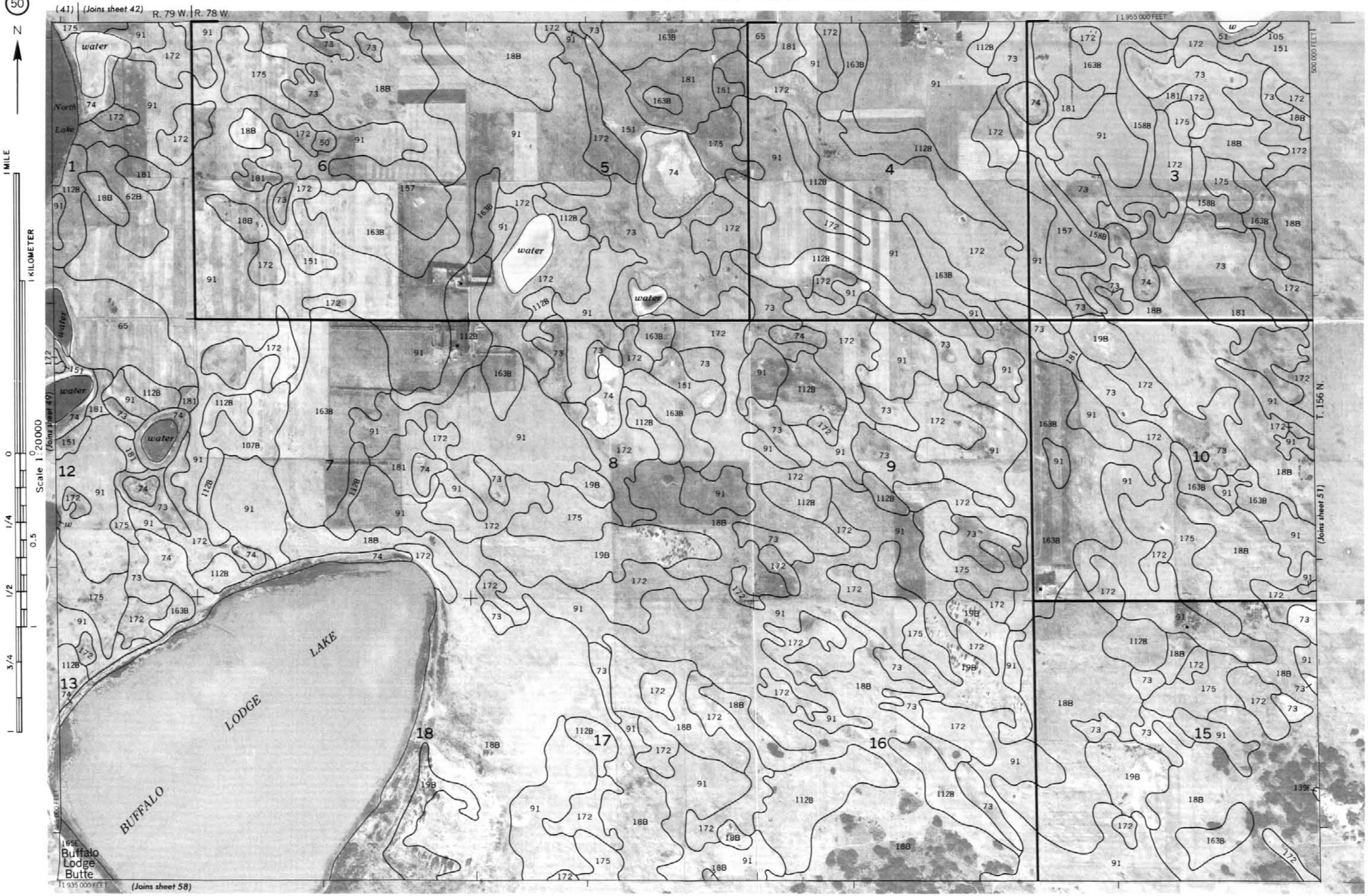
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 48

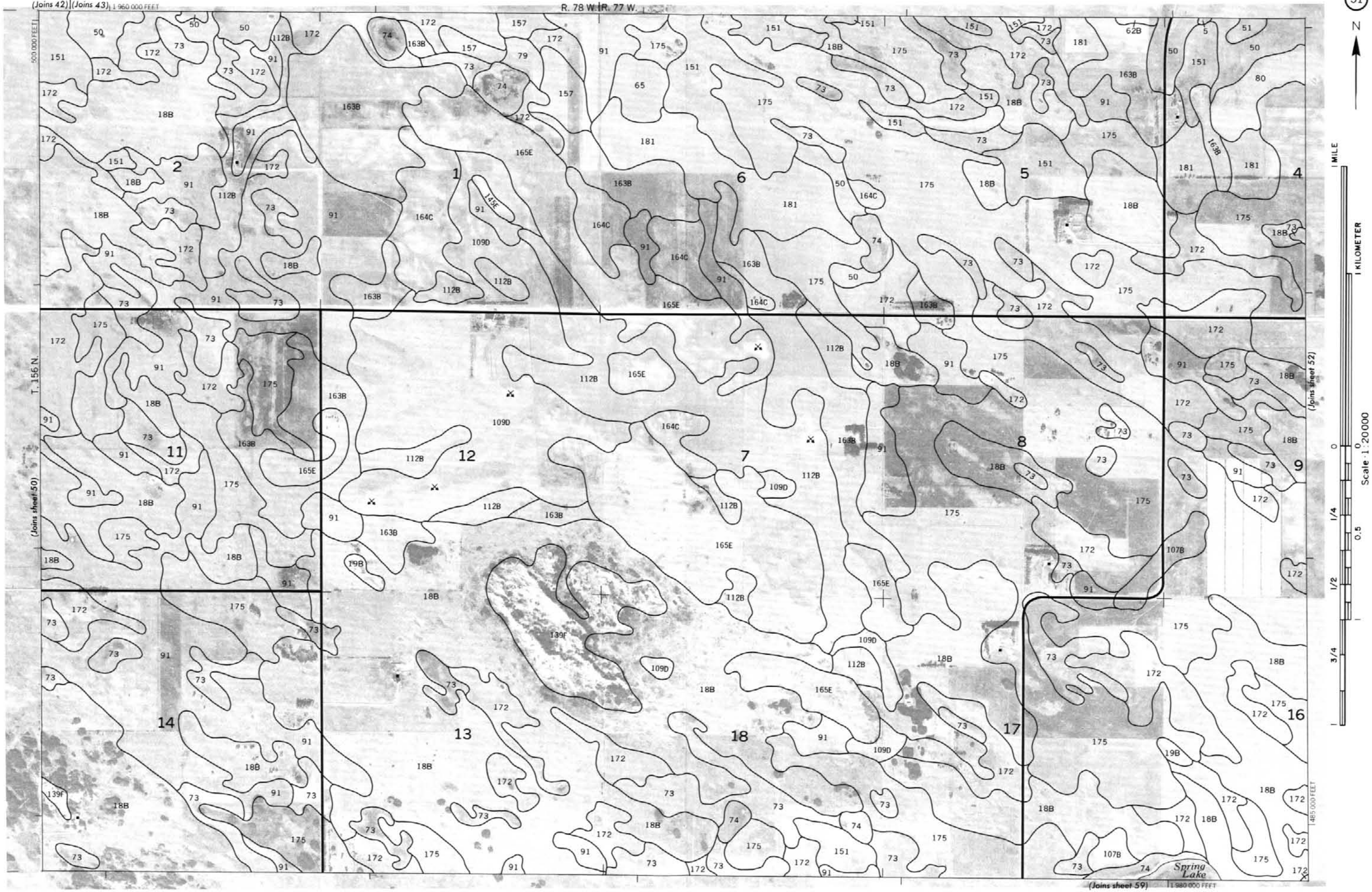


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

50

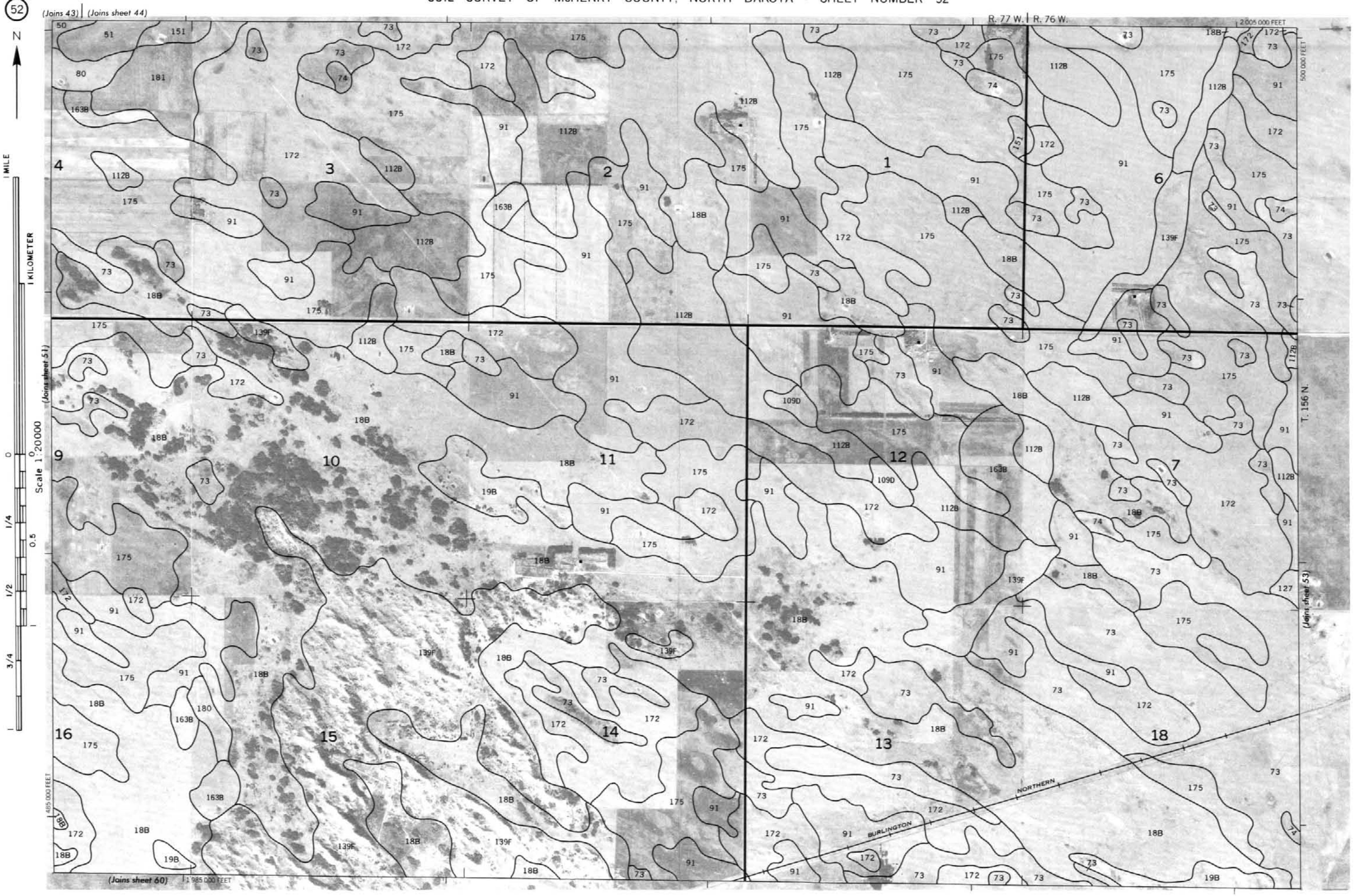


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

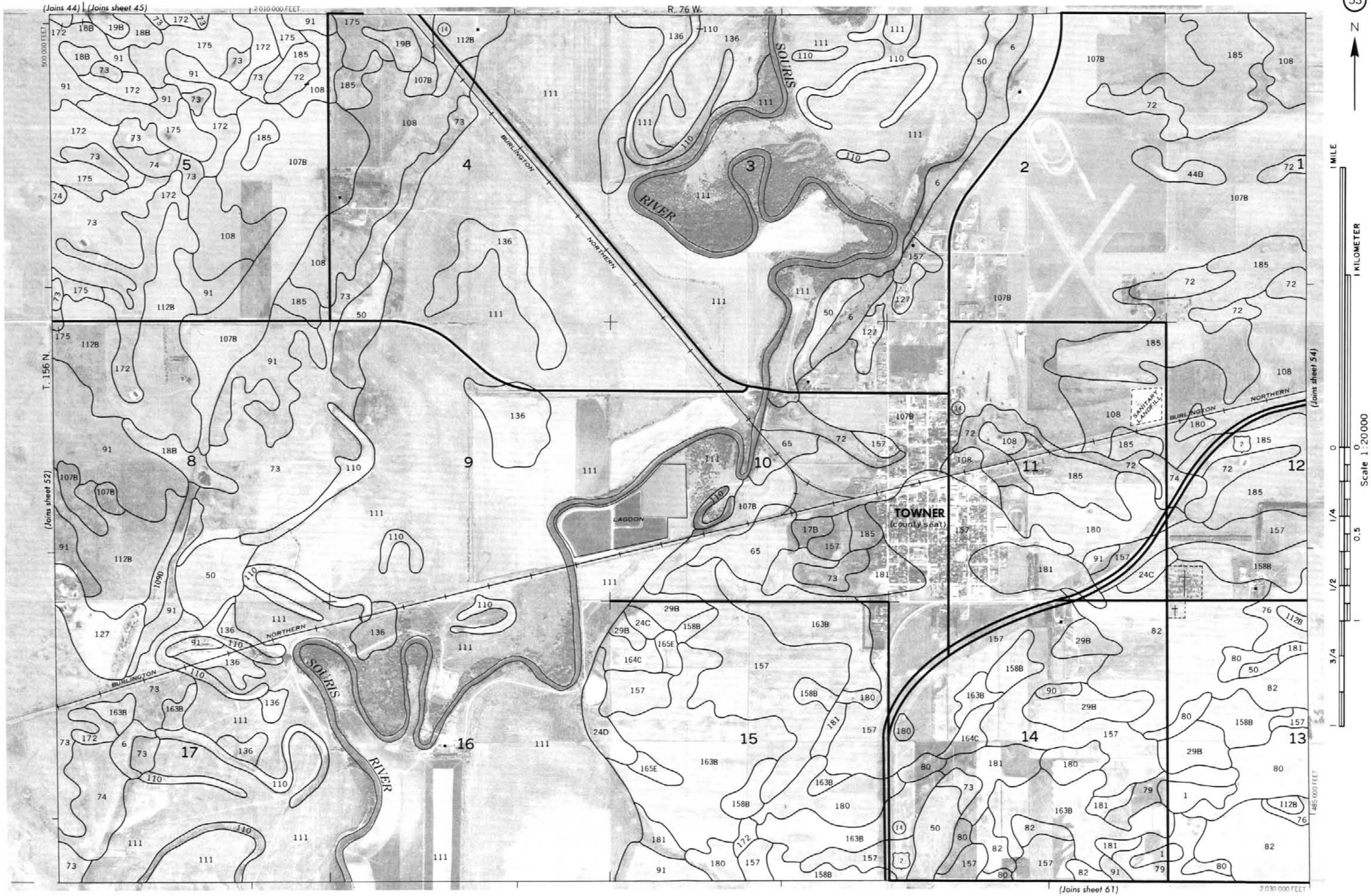


McHENRY COUNTY, NORTH DAKOTA NO. 51

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



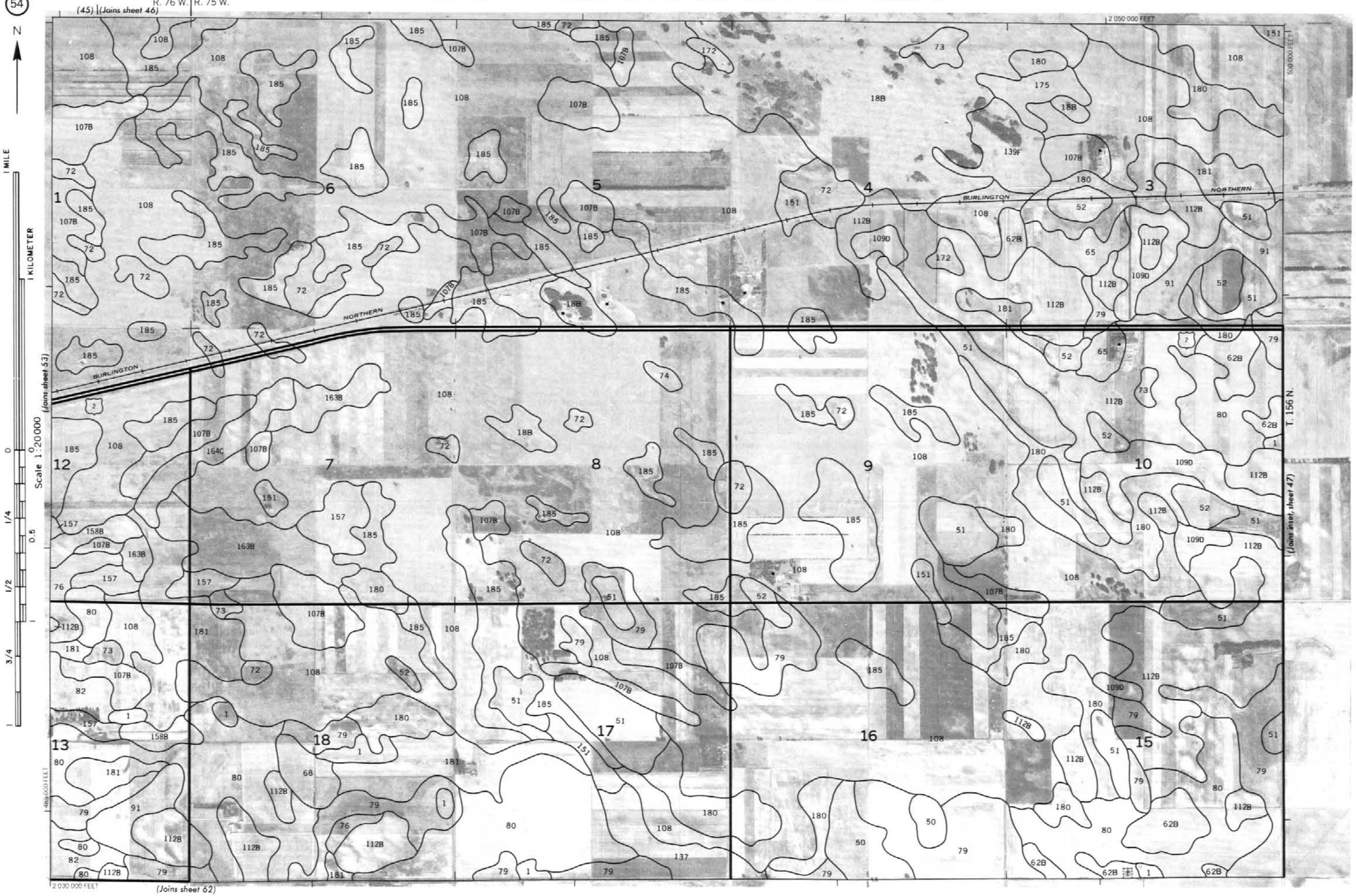
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 53

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 54



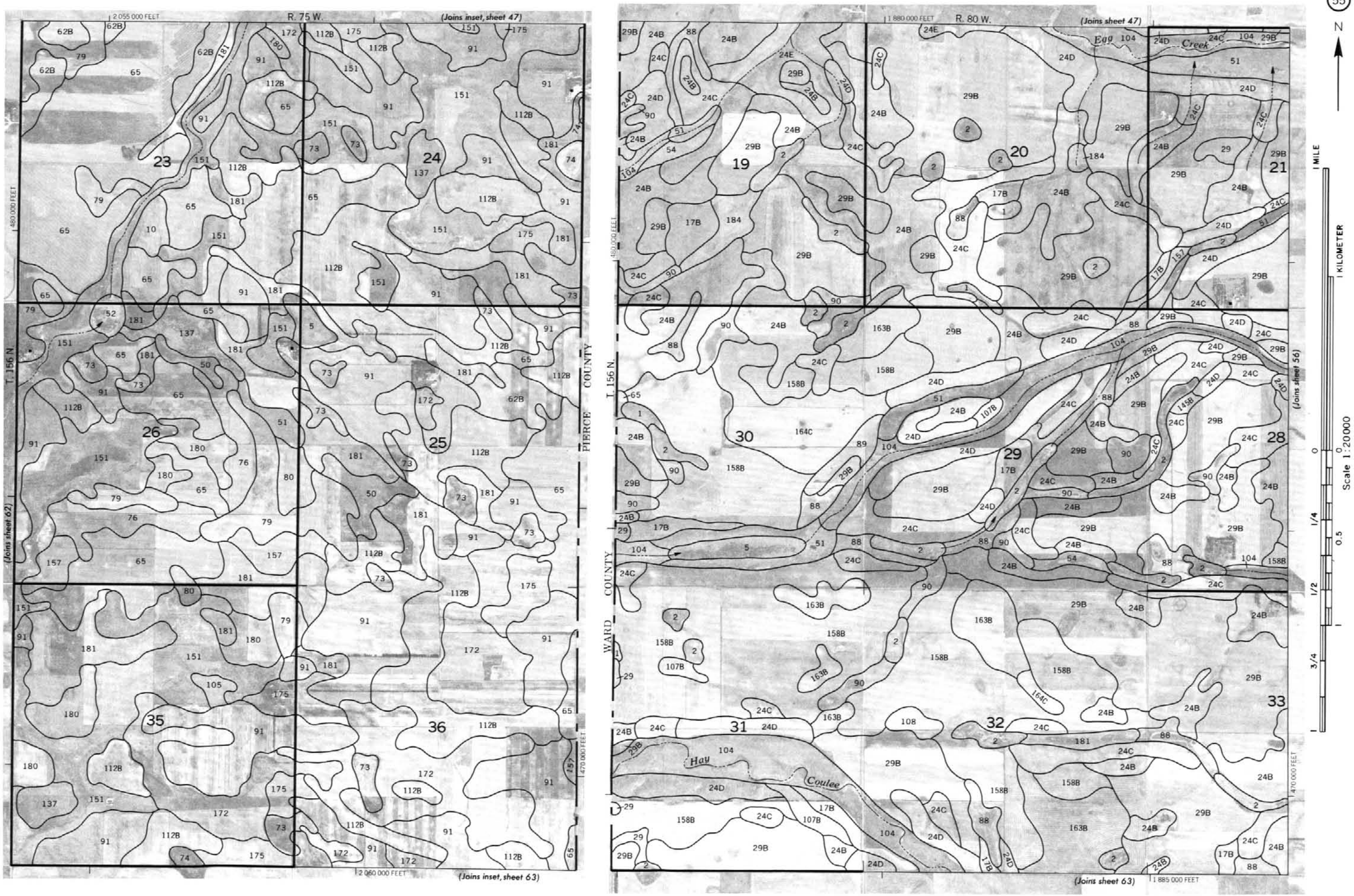
This soil survey map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 54

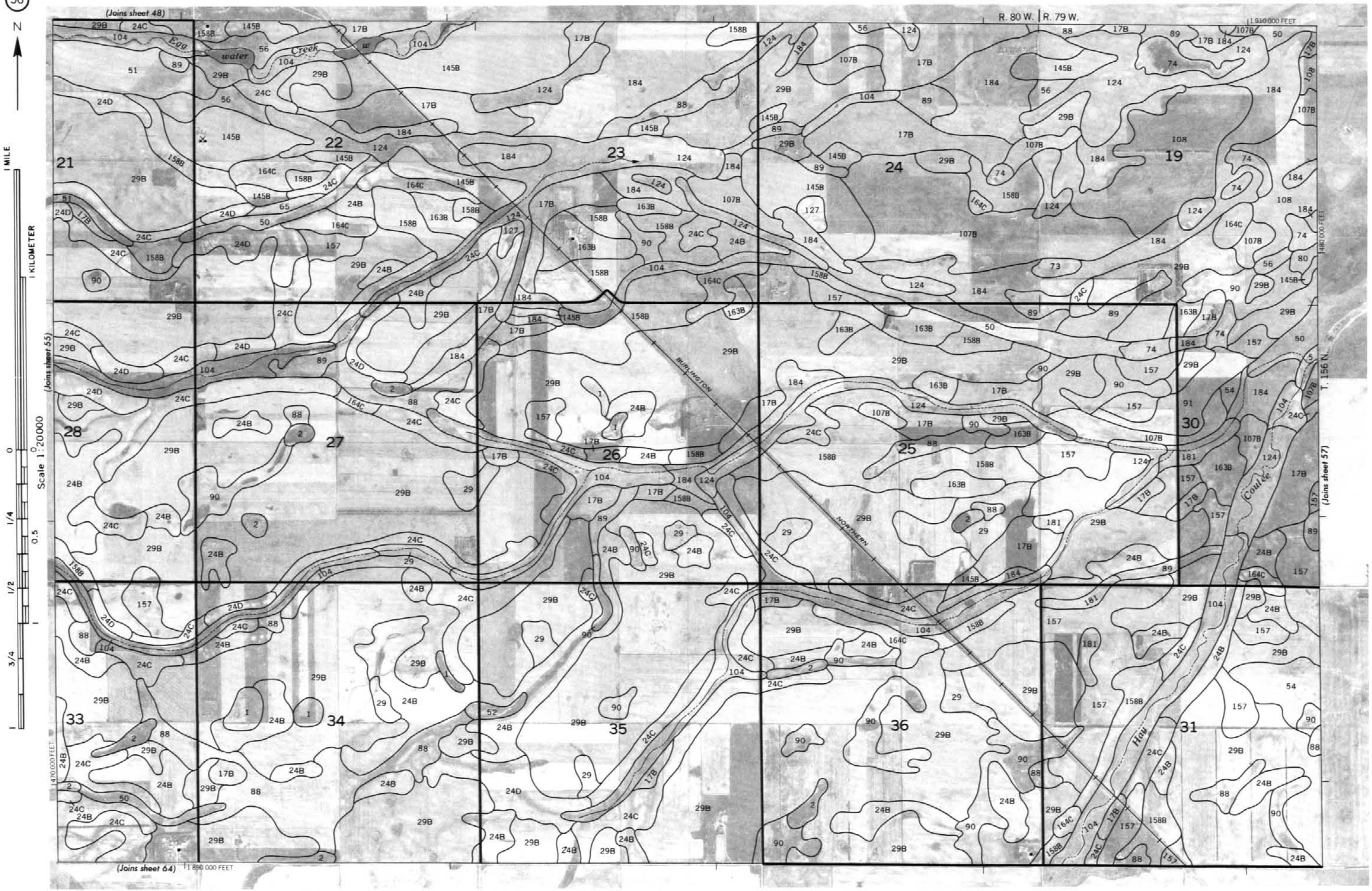
55

McHENRY COUNTY, NORTH DAKOTA NO. 55

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

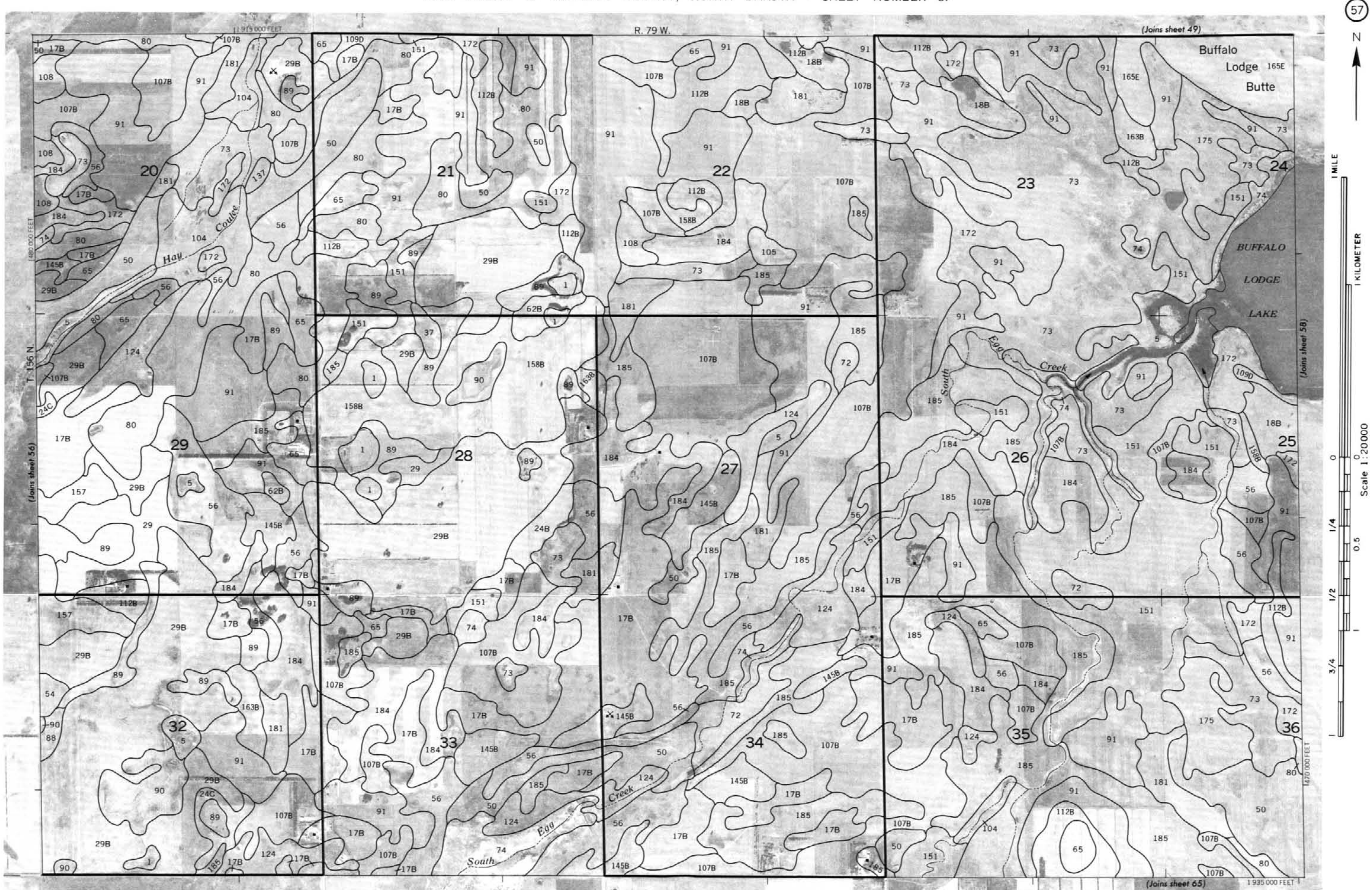


SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 56



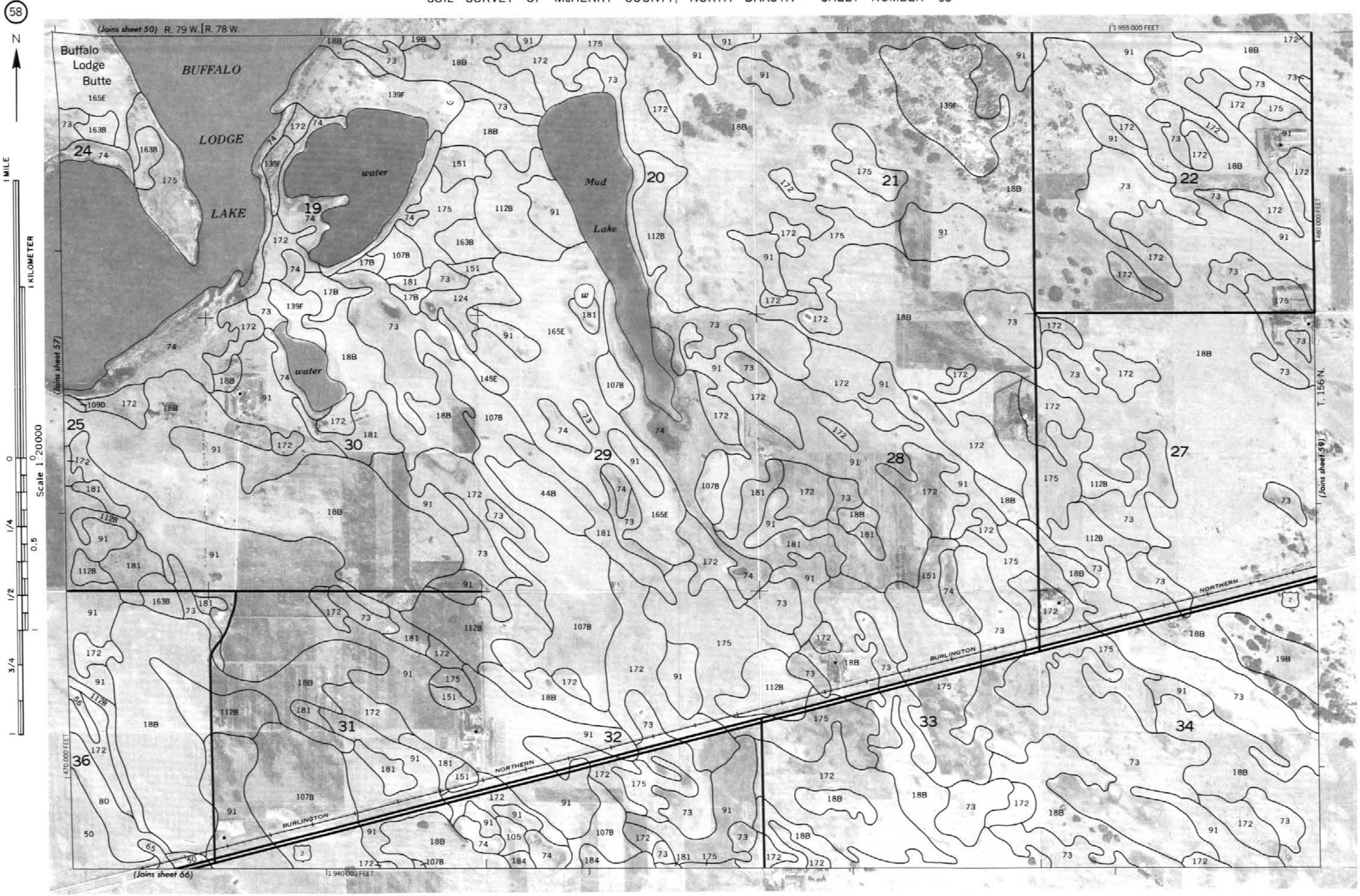
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 56



McHENRY COUNTY, NORTH DAKOTA NO. 57

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



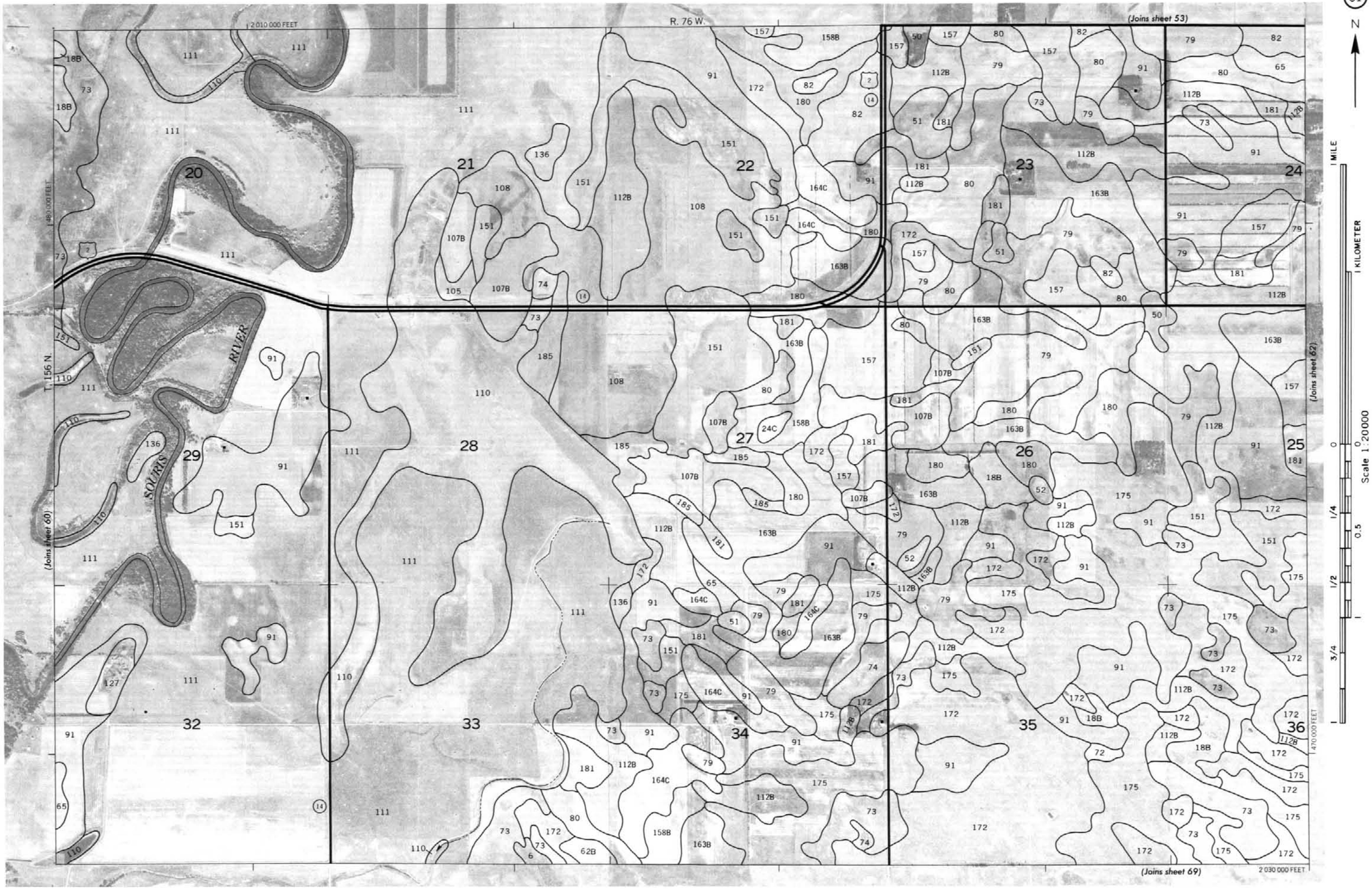
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 59

This soil survey map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

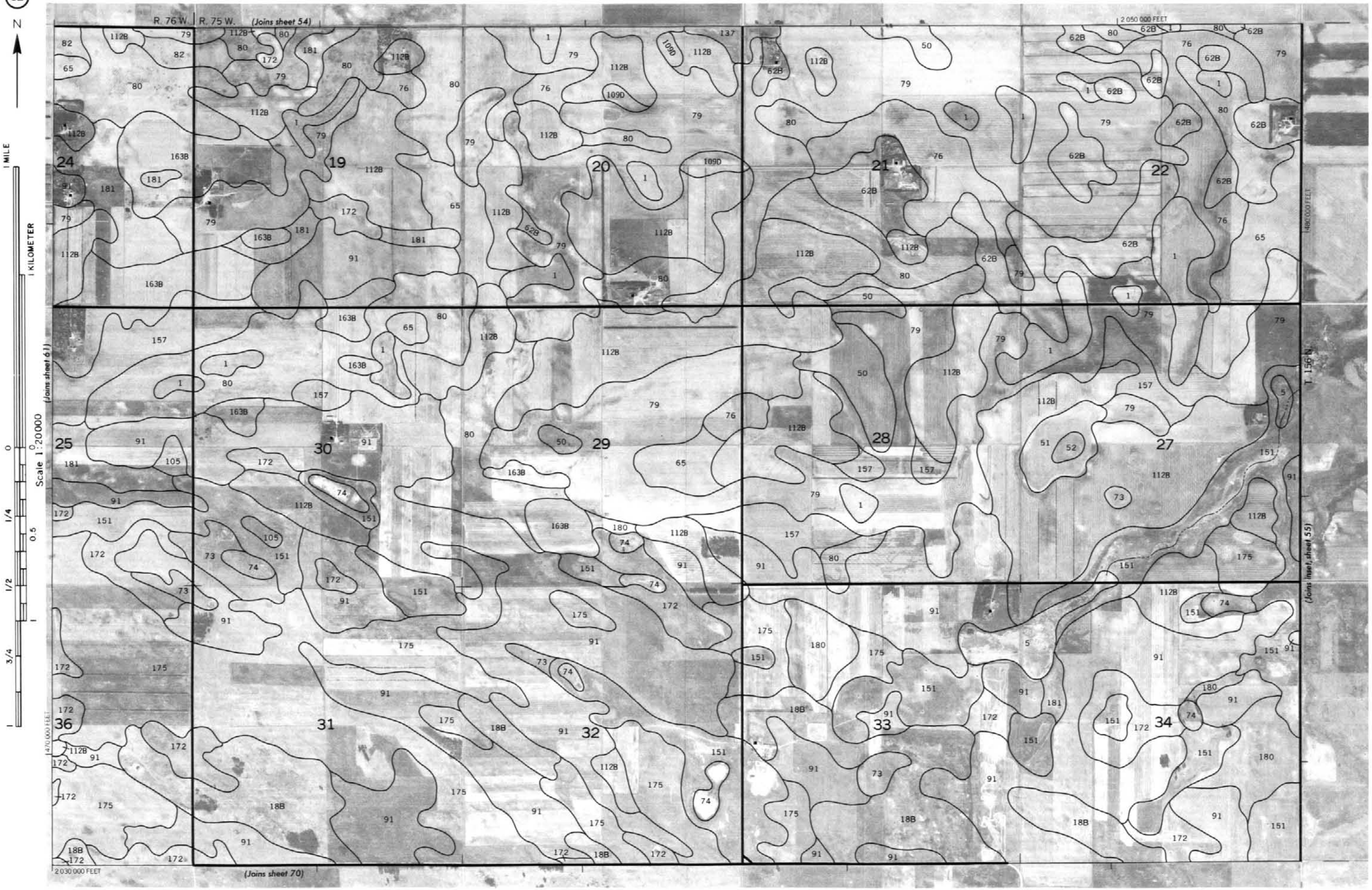
60

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



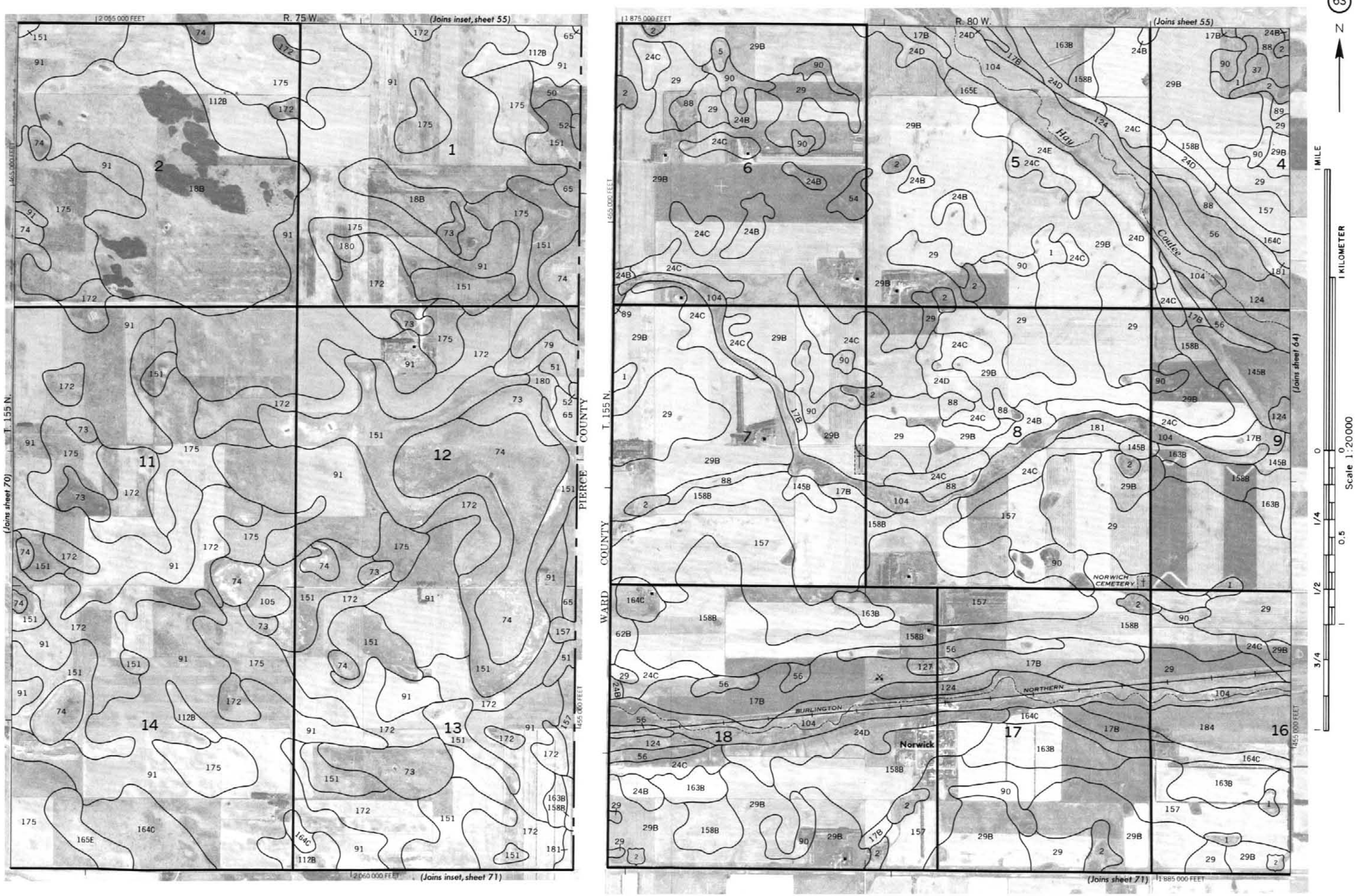
McHENRY COUNTY, NORTH DAKOTA NO. 61

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



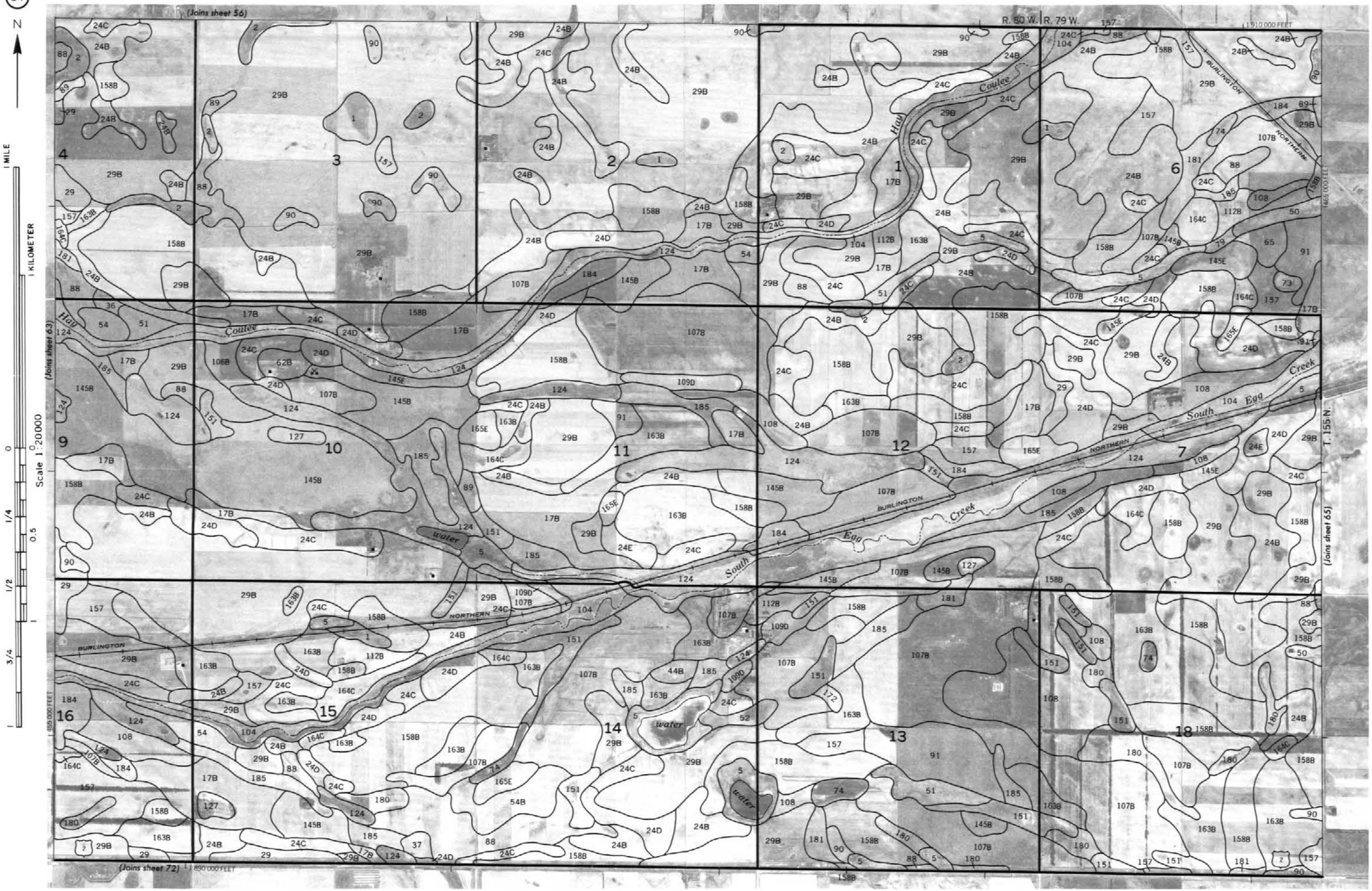
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 62

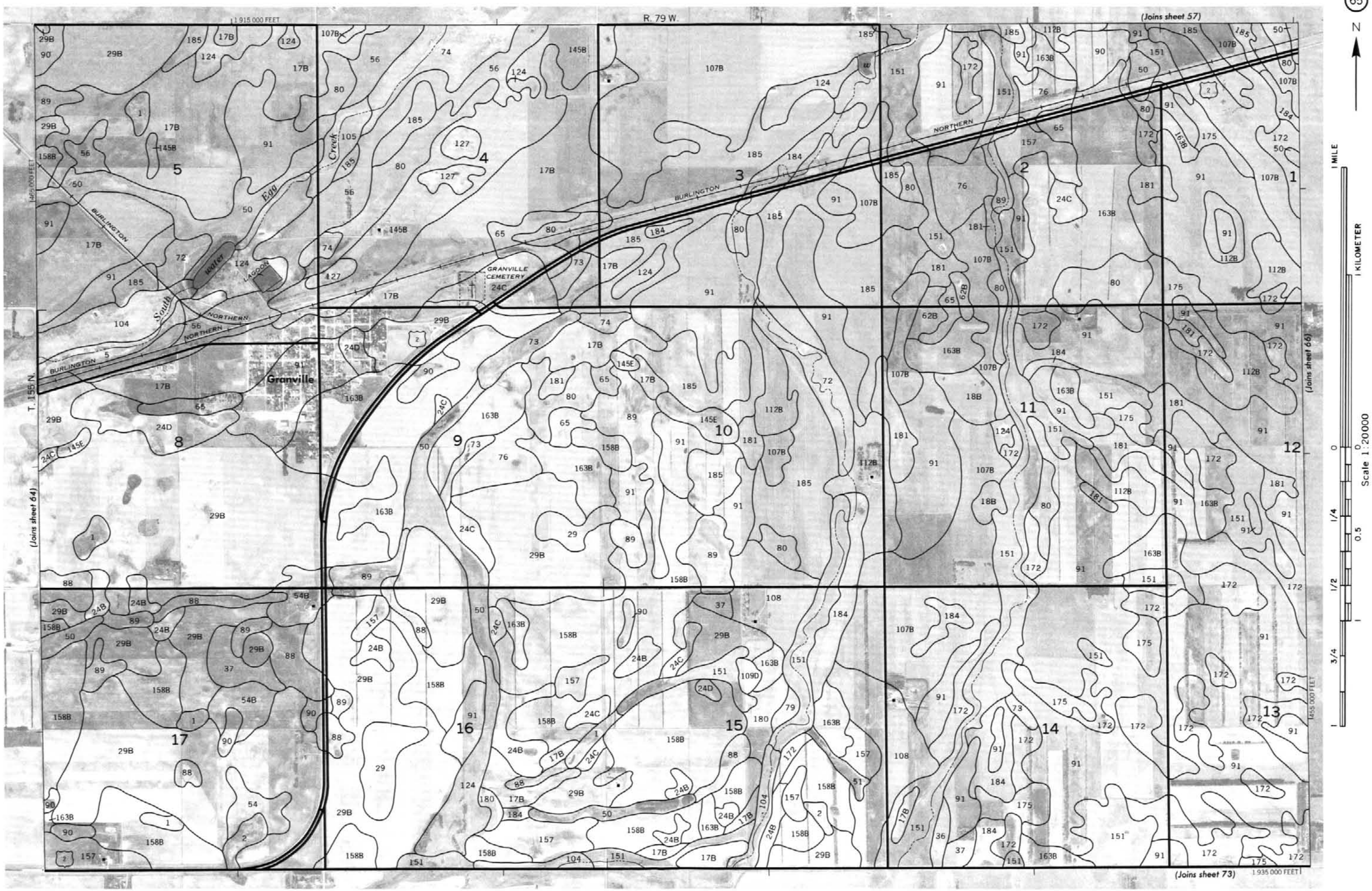


McHENRY COUNTY, NORTH DAKOTA NO. 63

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 65

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 66

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

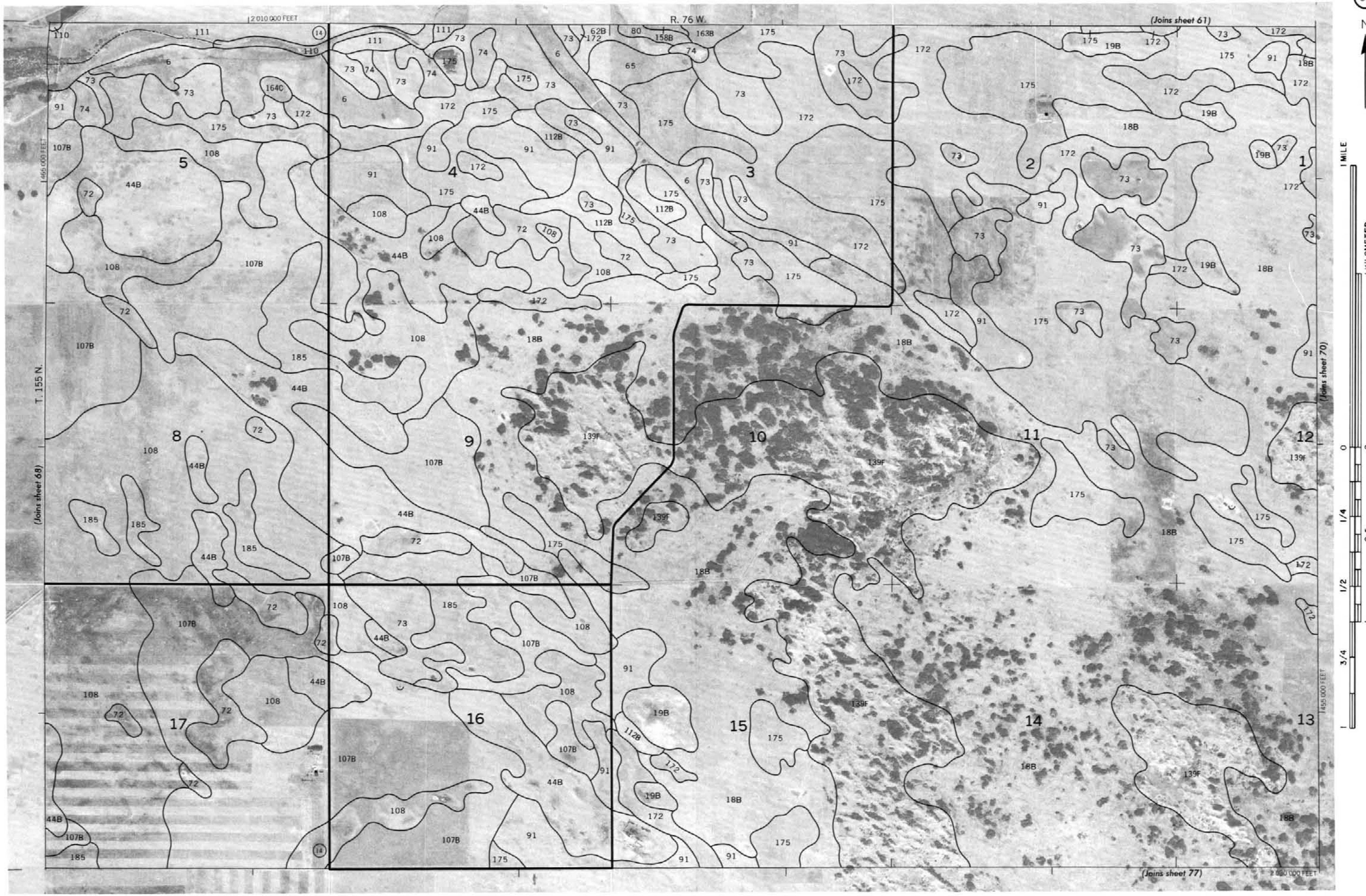
McHENRY COUNTY, NORTH DAKOTA NO. 67

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

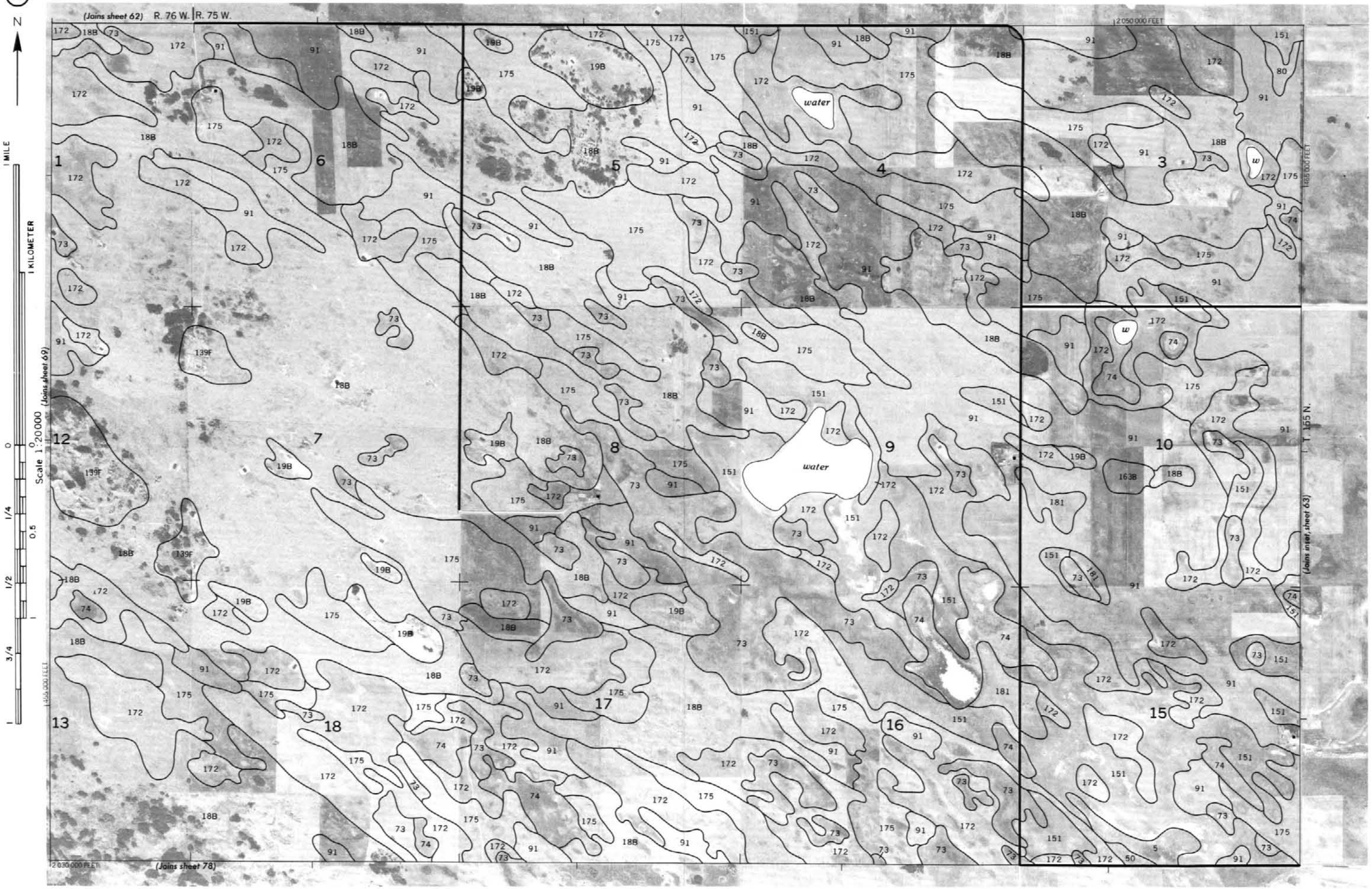
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 68

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 70

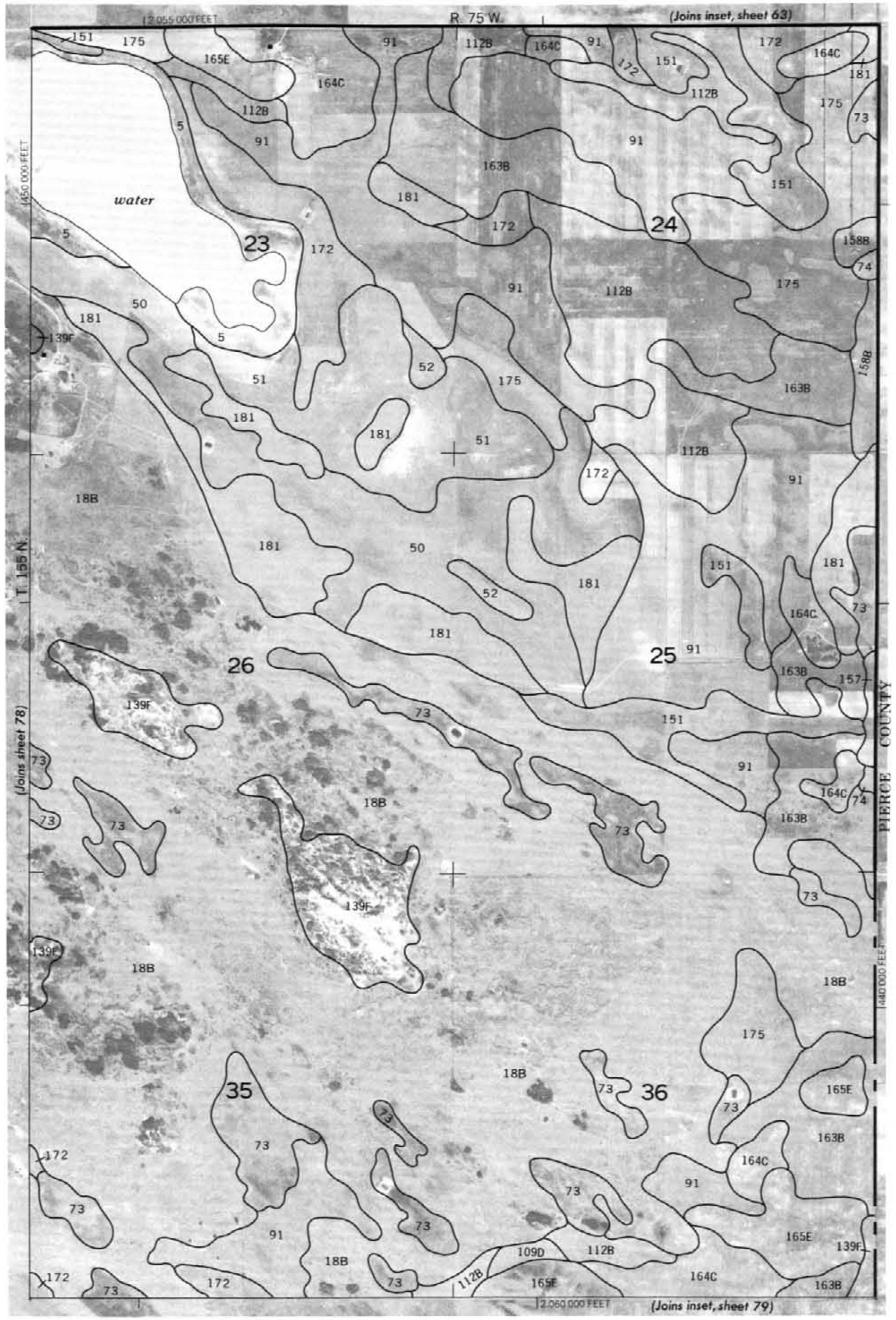


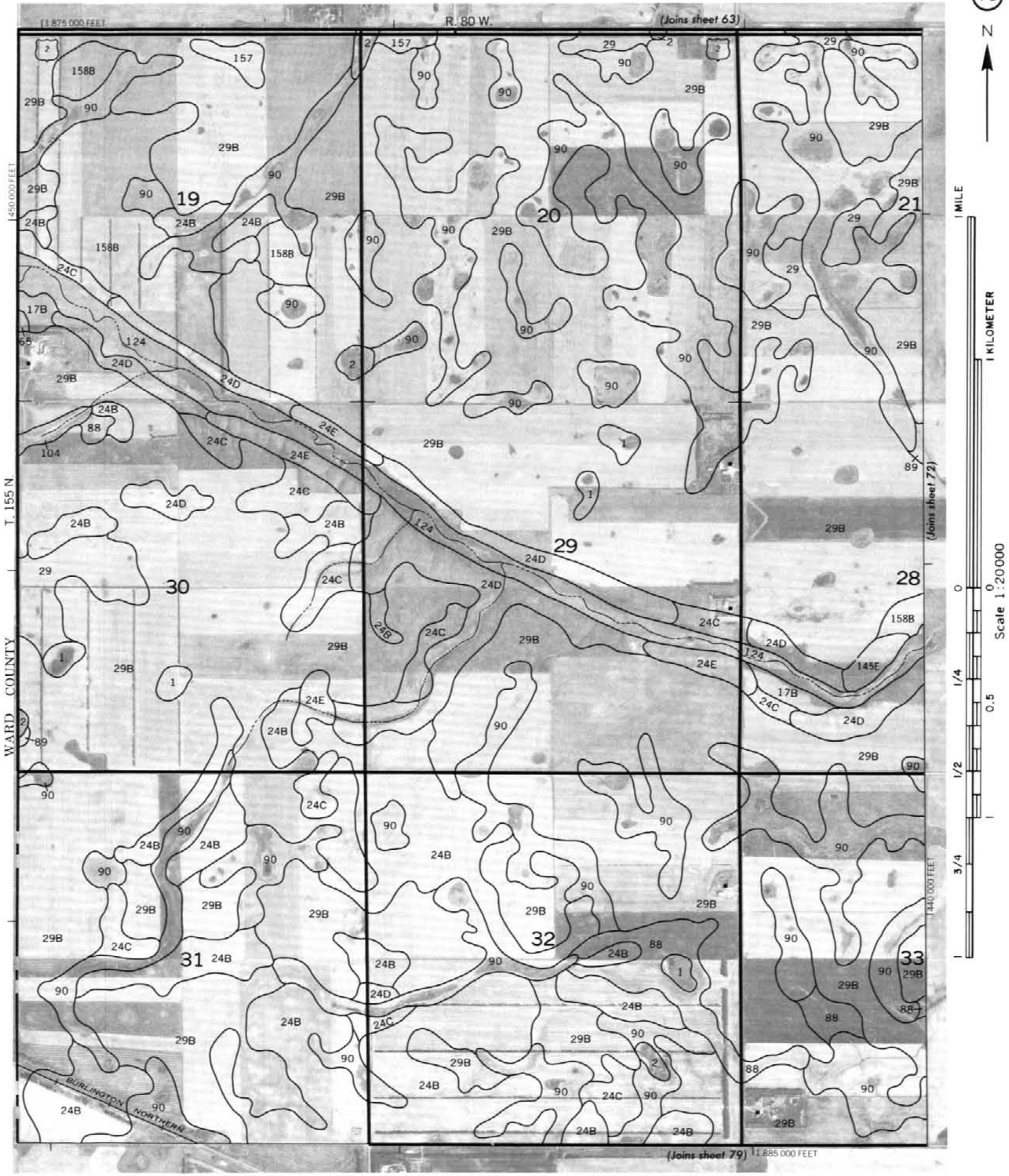
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

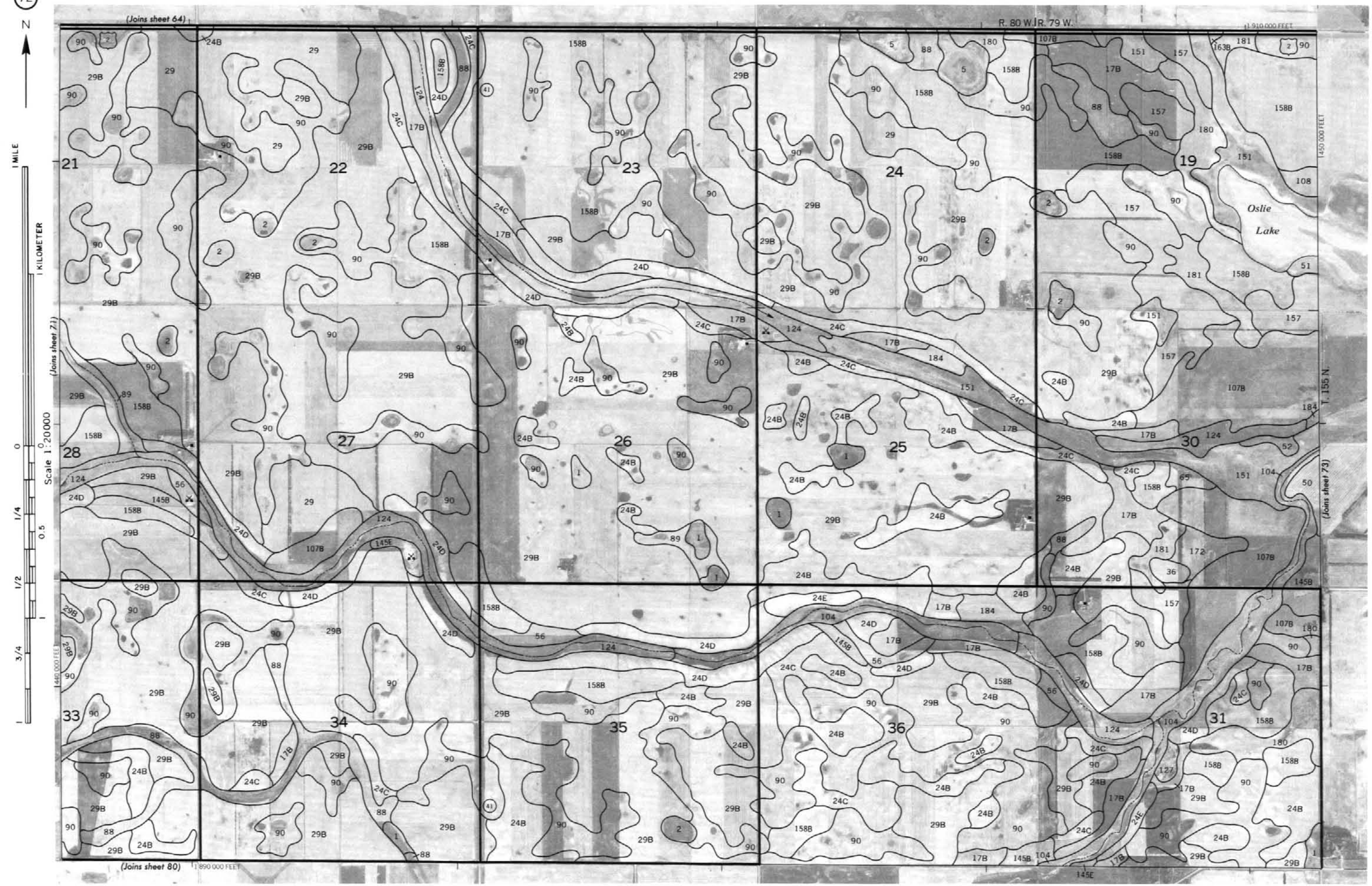
McHENRY COUNTY, NORTH DAKOTA NO. 70

McHENRY COUNTY, NORTH DAKOTA NO. 71

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



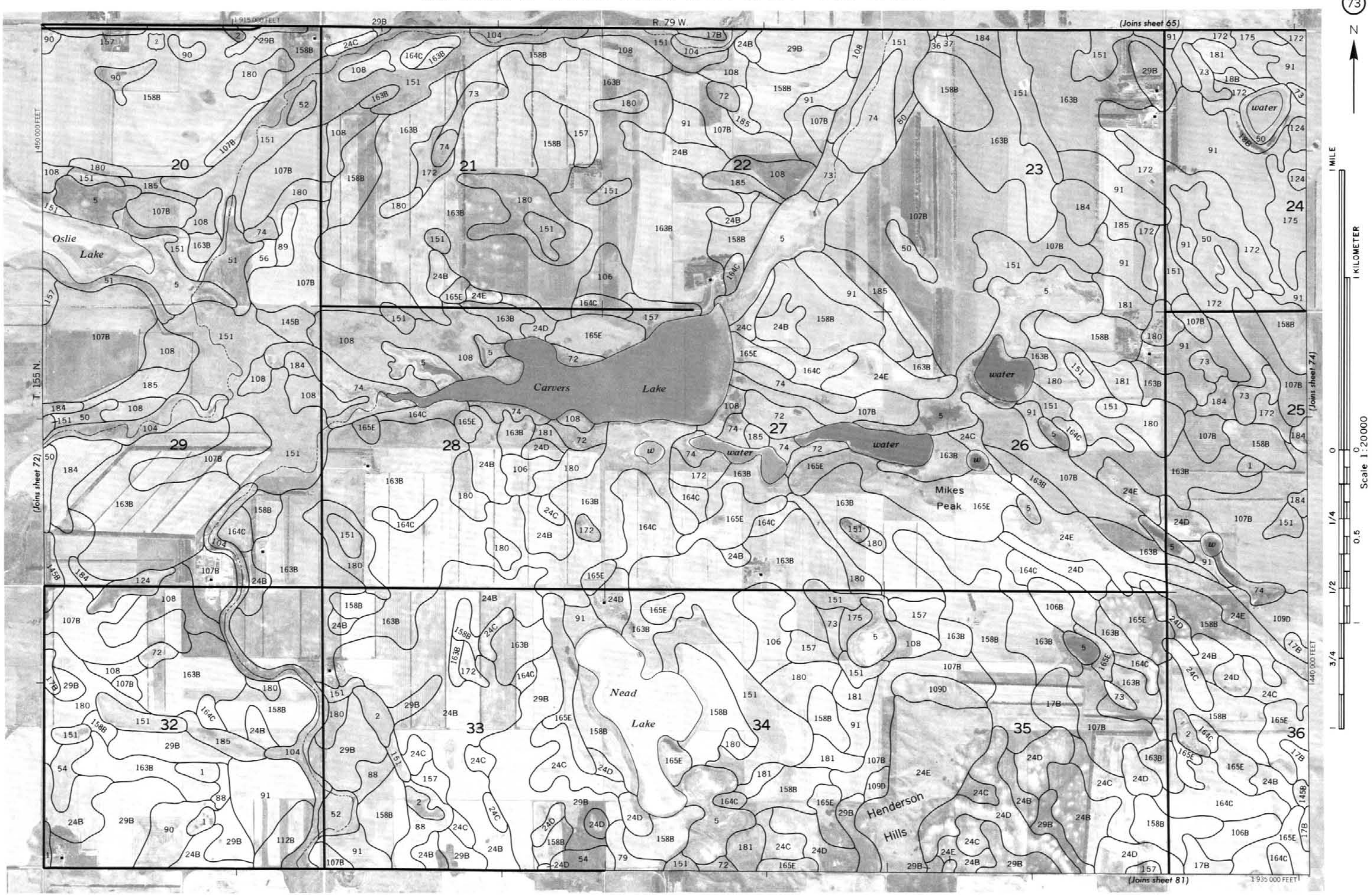




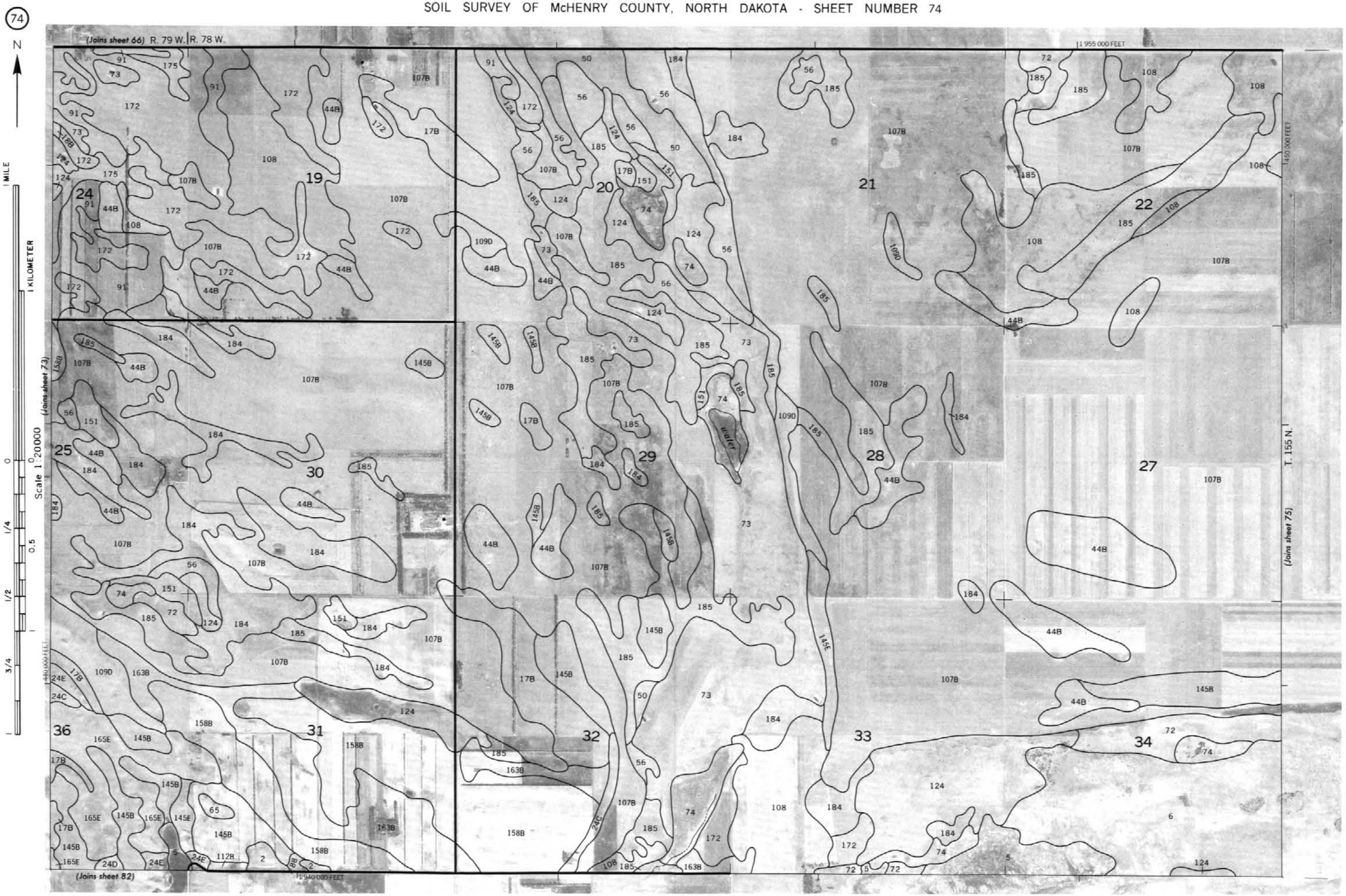
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 73

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 74

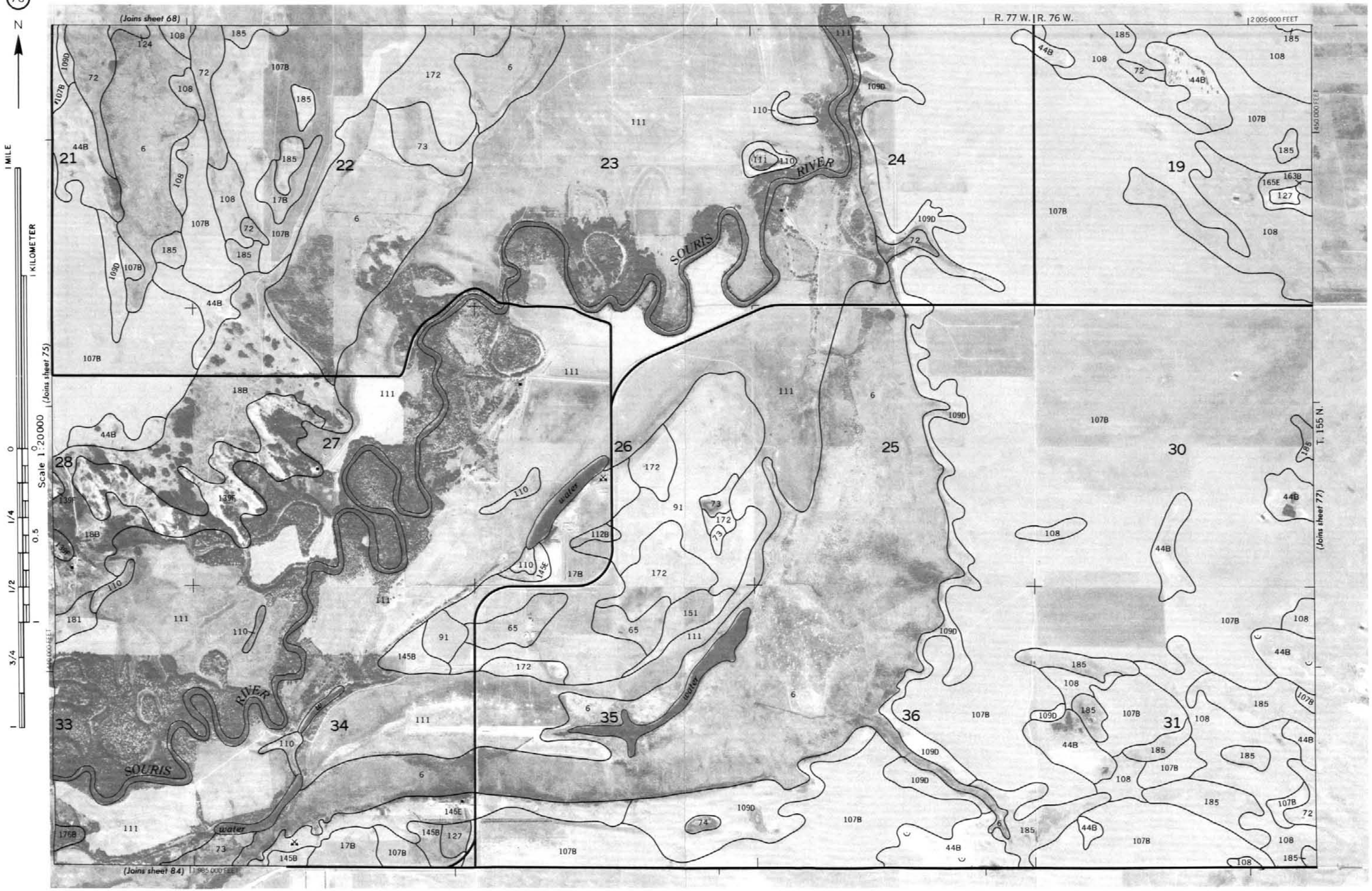


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

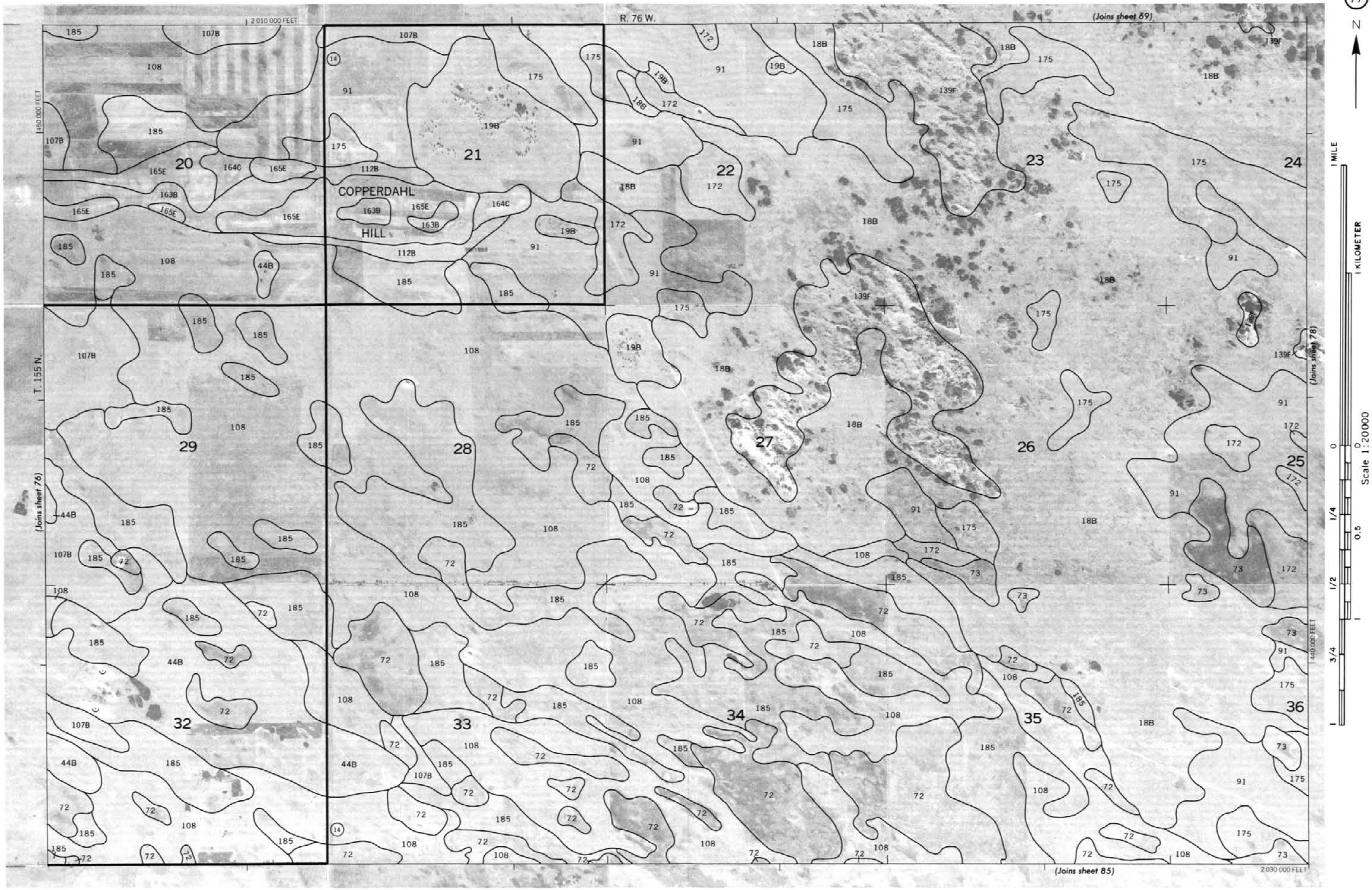
McHENRY COUNTY, NORTH DAKOTA NO. 74

McHENRY COUNTY, NORTH DAKOTA NO. 75

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



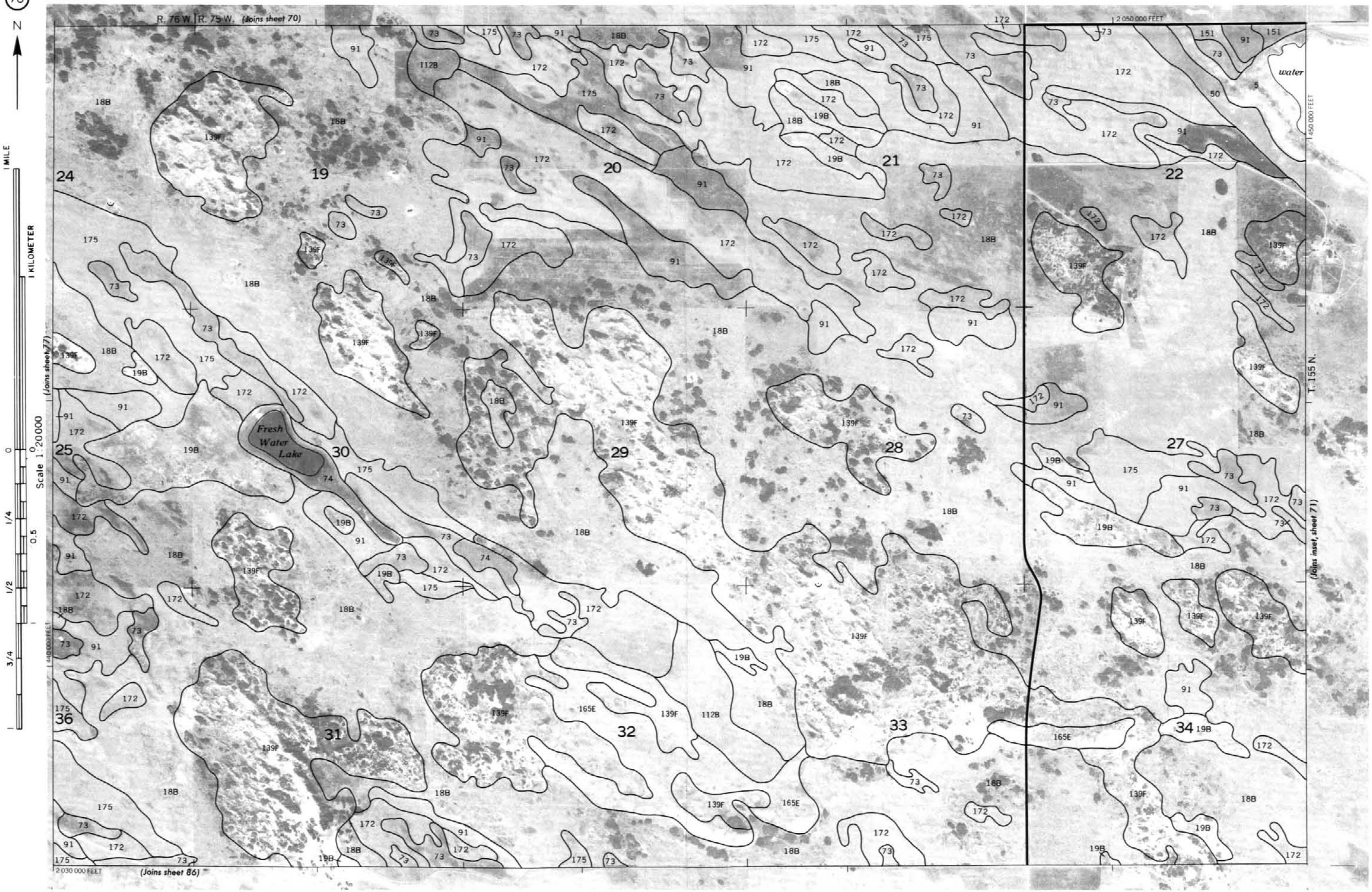
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 77

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

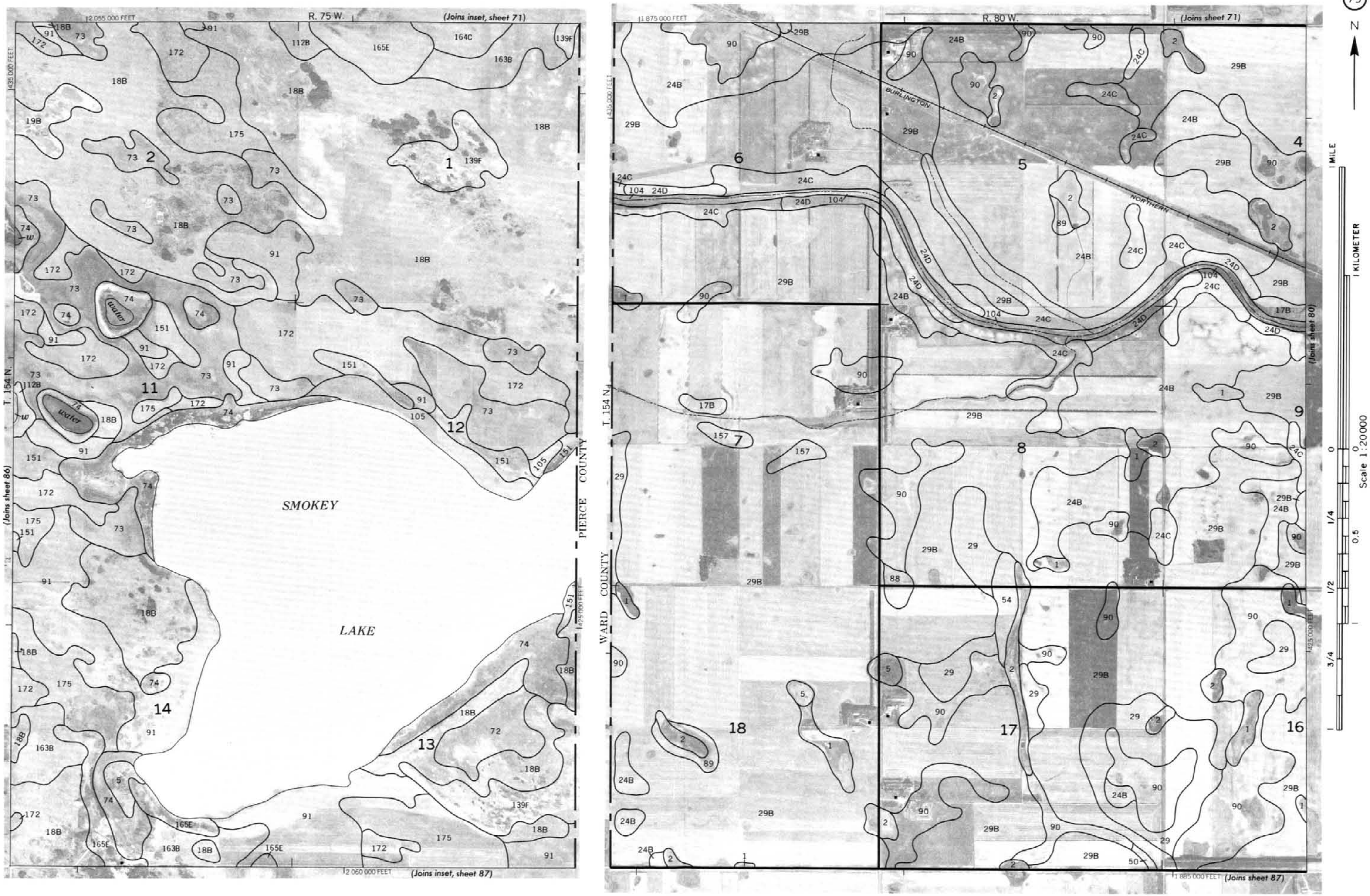
78

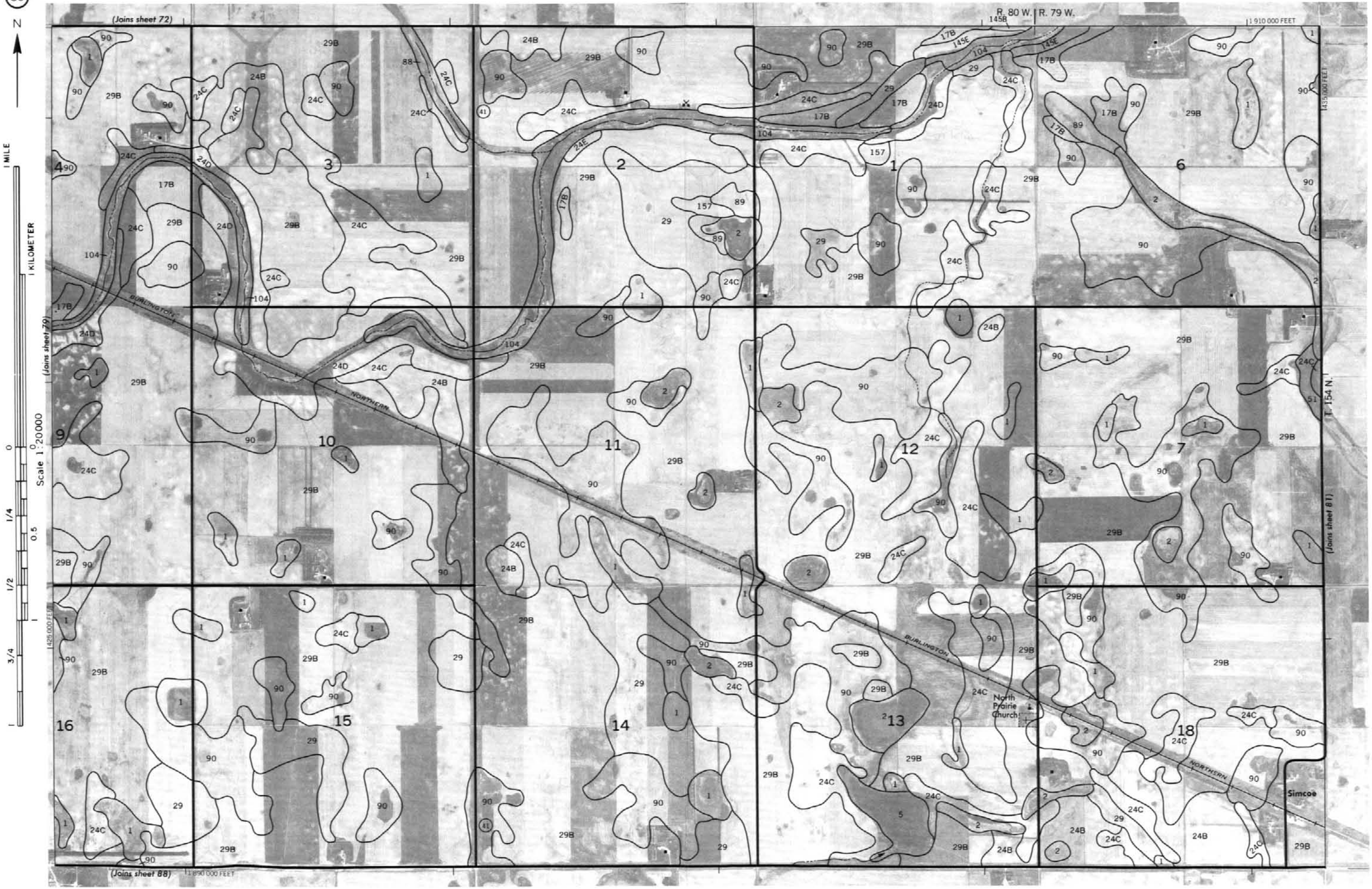


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

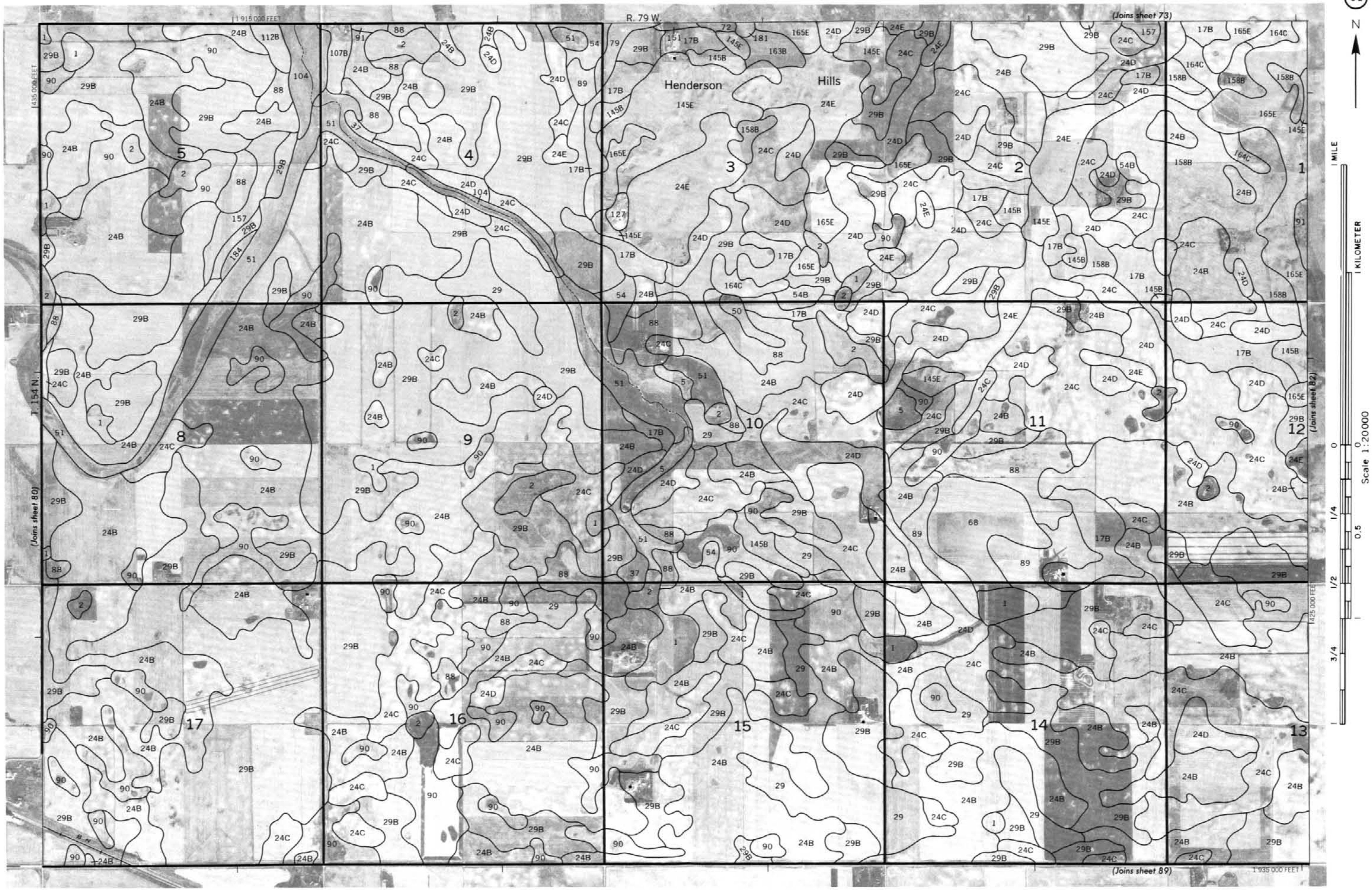
McHENRY COUNTY, NORTH DAKOTA NO. 79

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



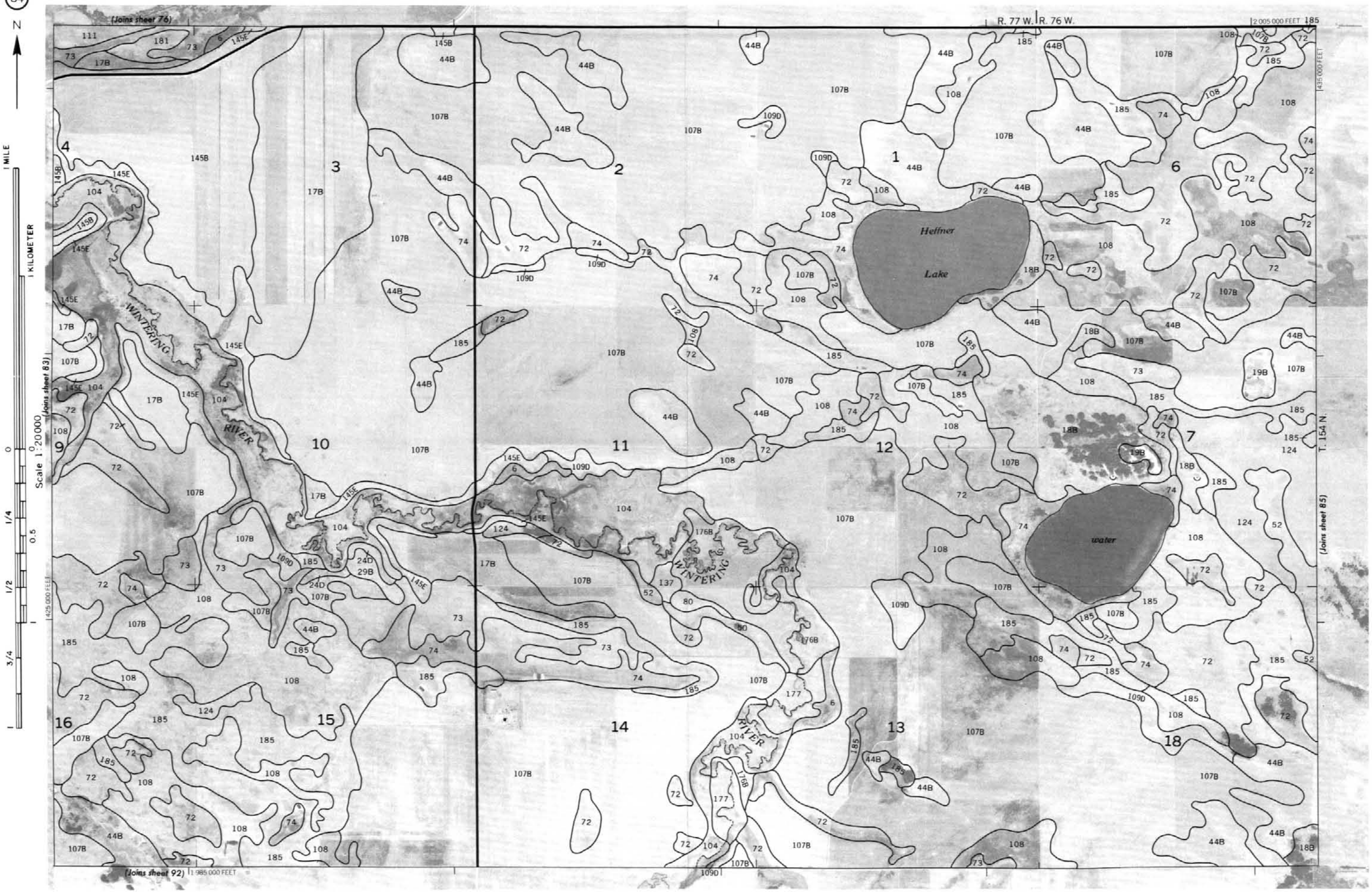
MCHENRY COUNTY, NORTH DAKOTA NO. 81

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

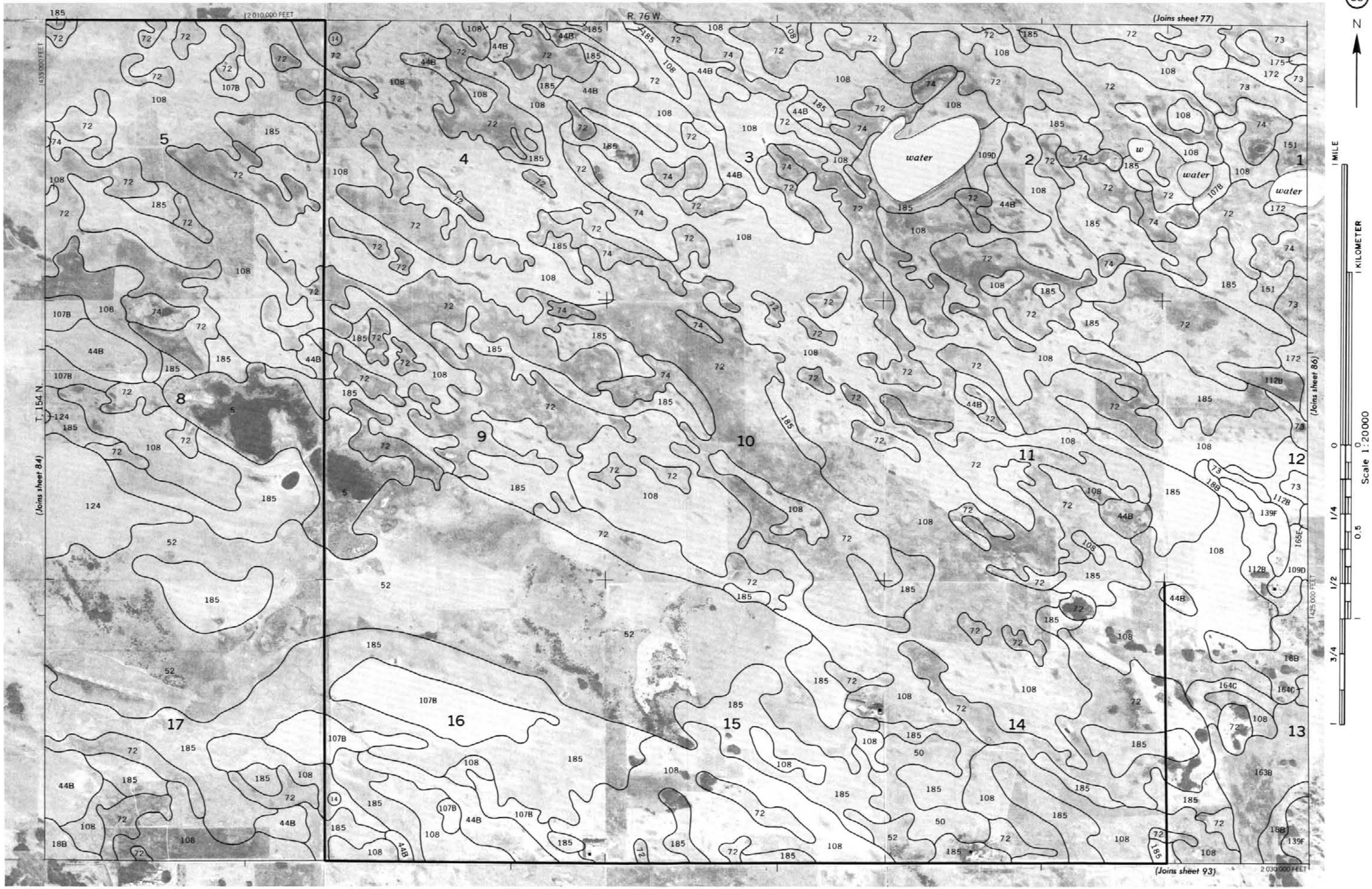
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 83

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

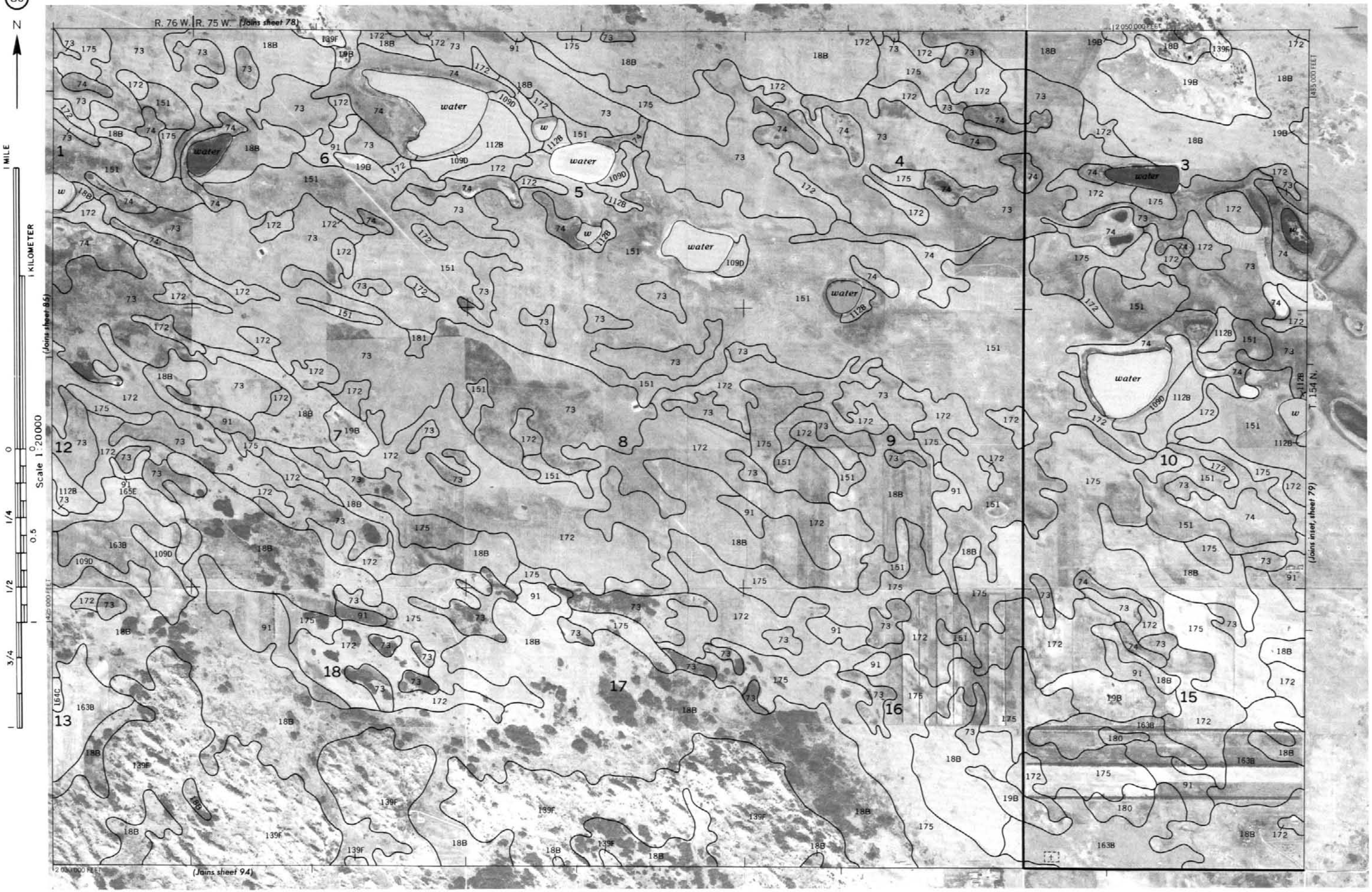


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

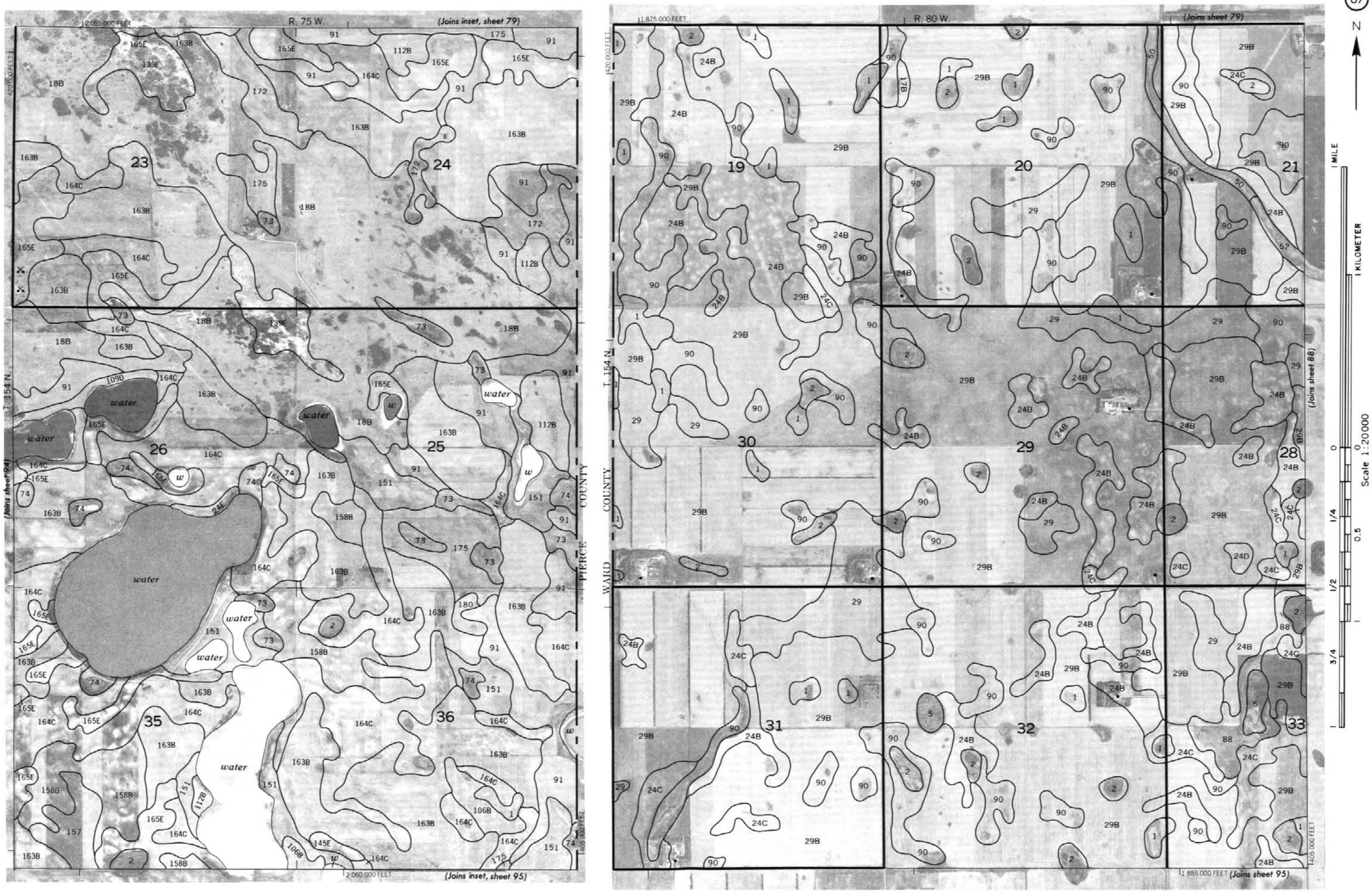


McHENRY COUNTY, NORTH DAKOTA NO. 85

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

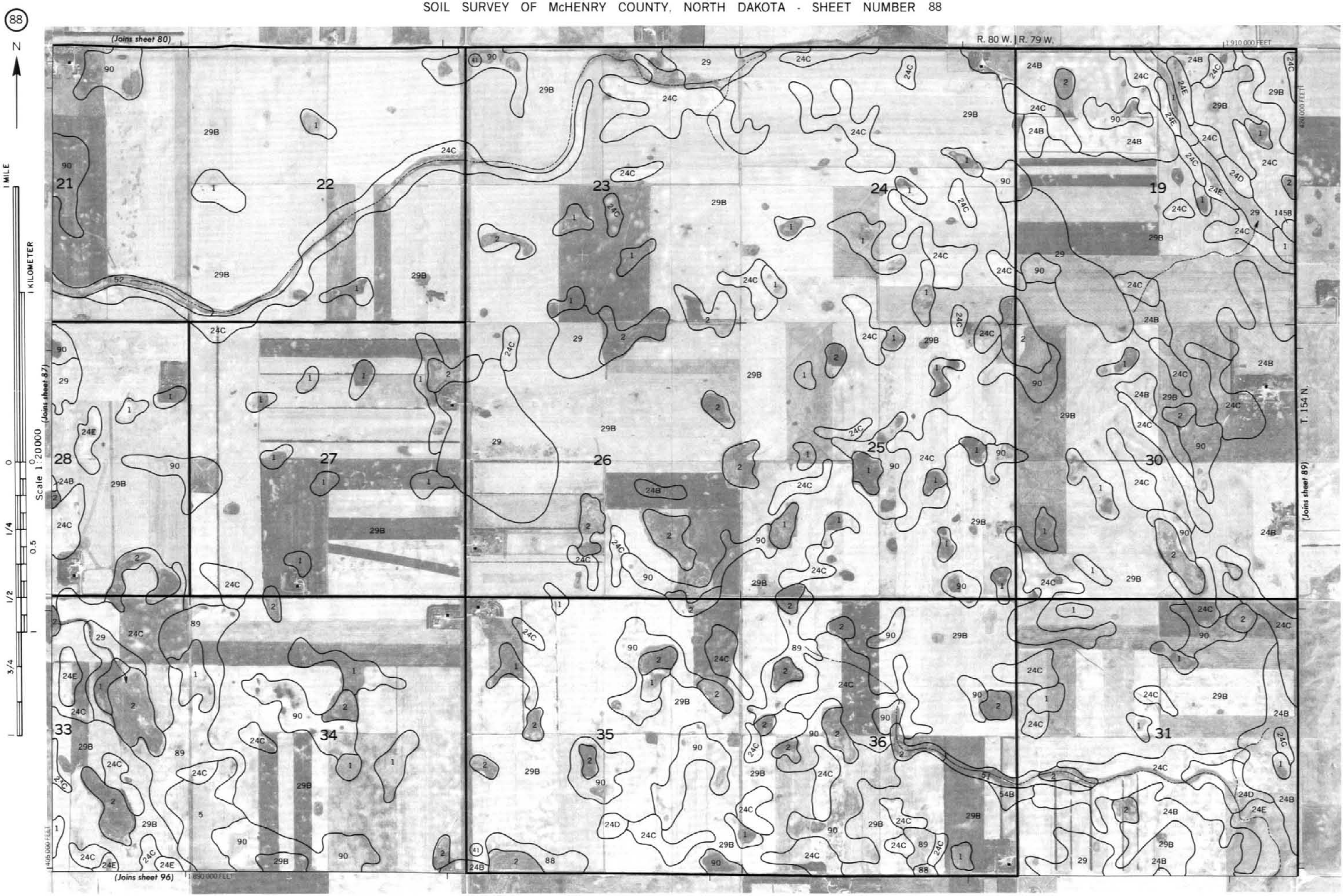


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



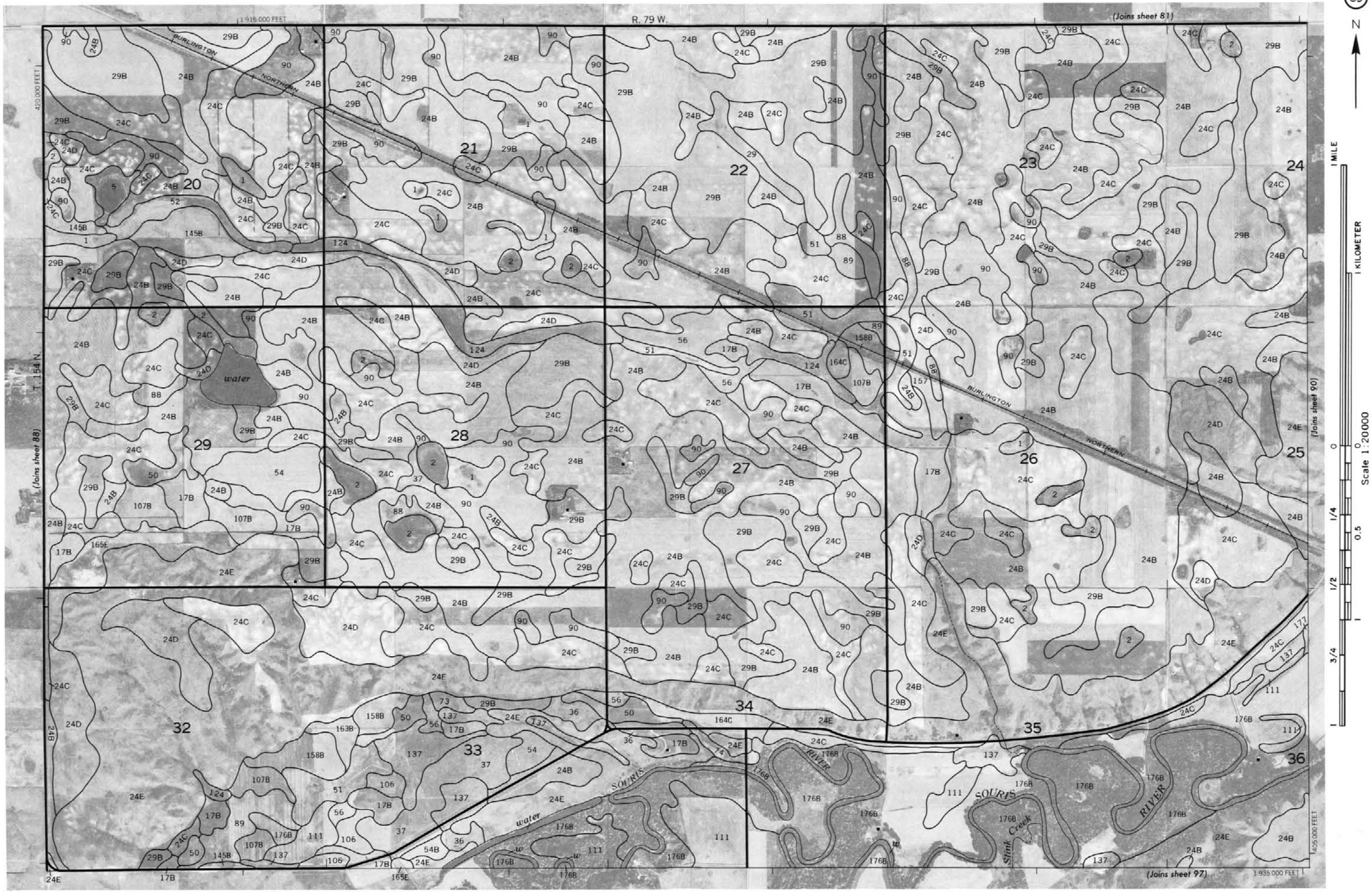
McHENRY COUNTY, NORTH DAKOTA NO. 87

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



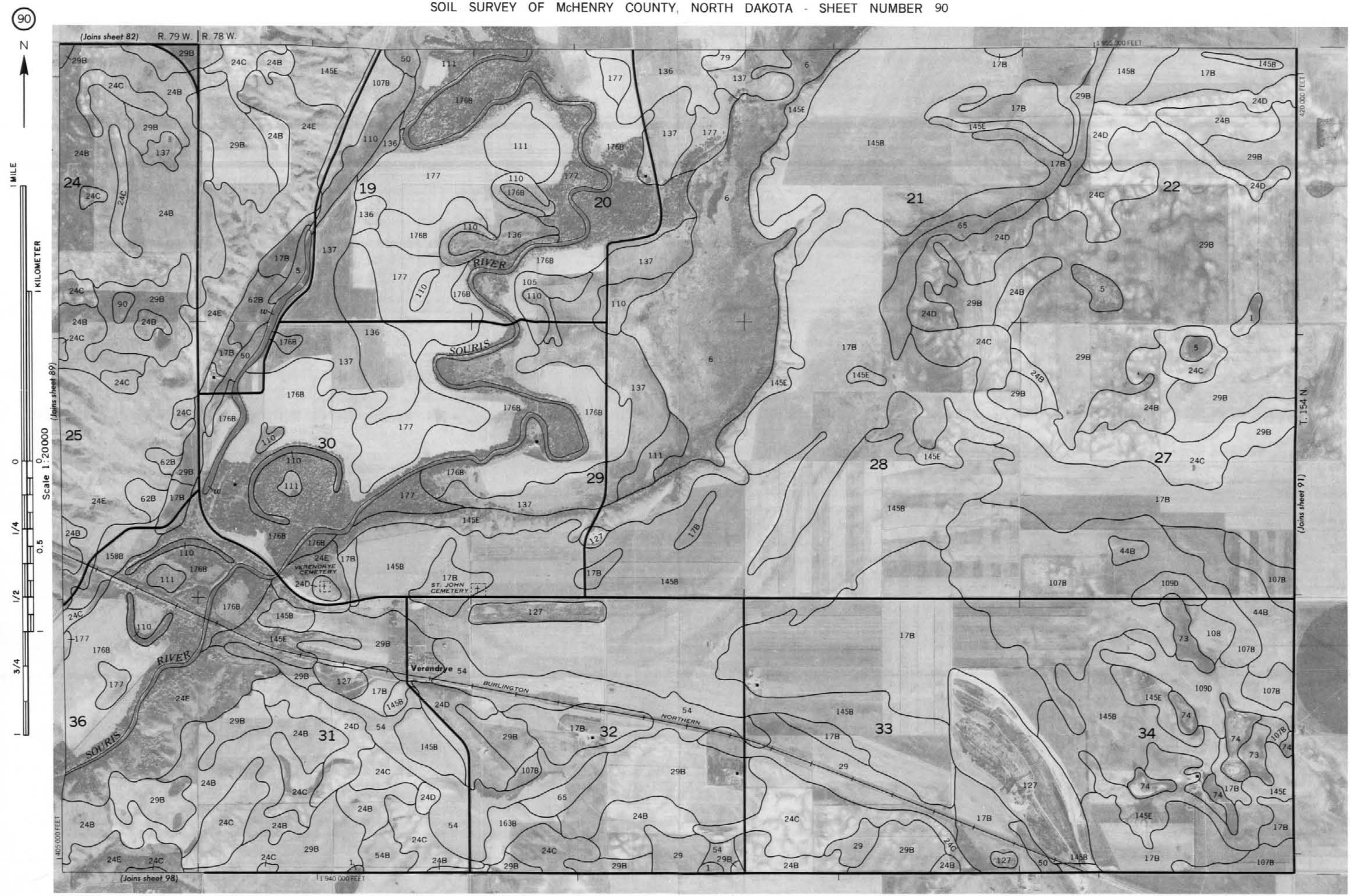
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

89



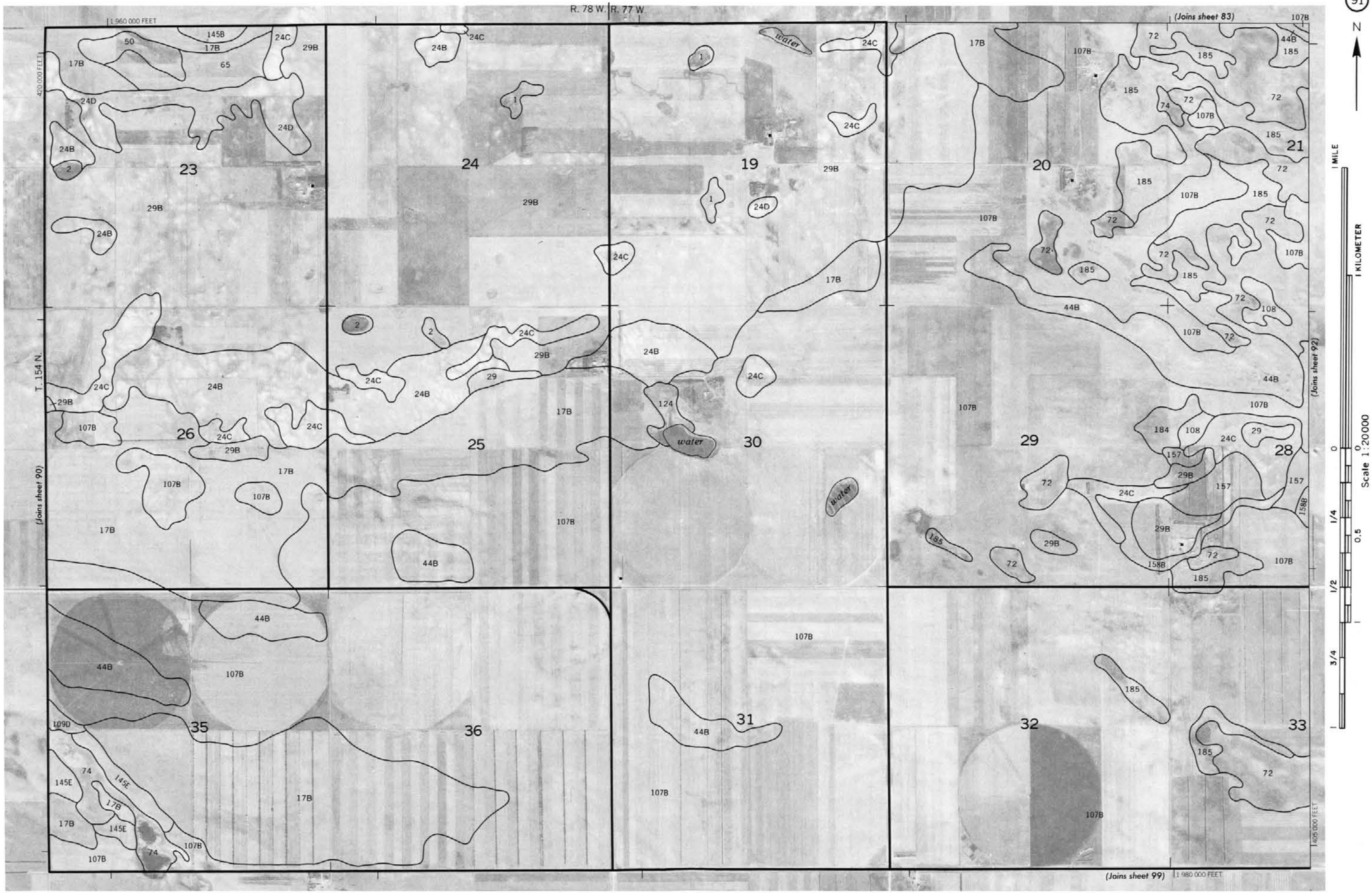
McHENRY COUNTY, NORTH DAKOTA NO. 89

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



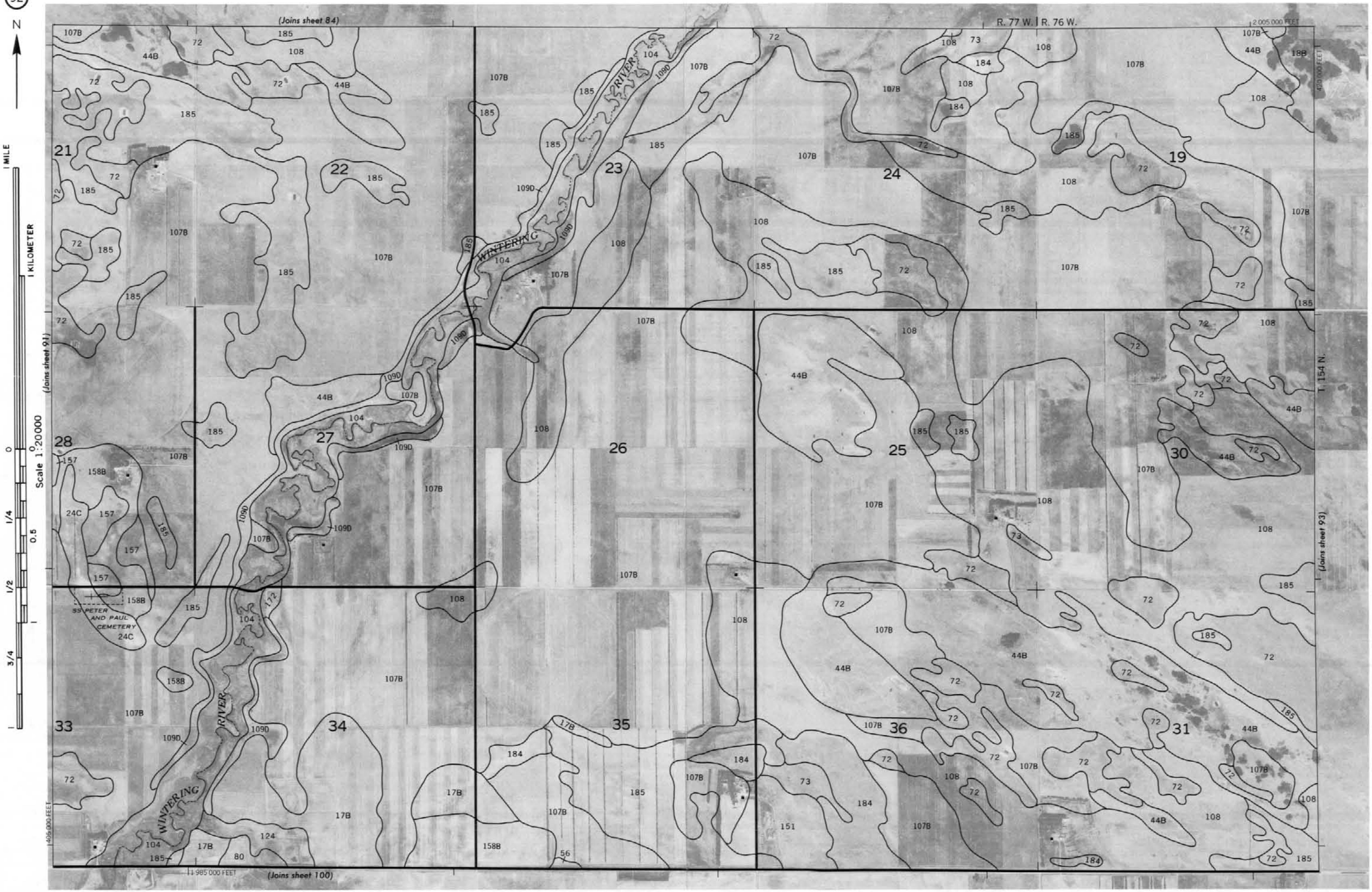
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 90

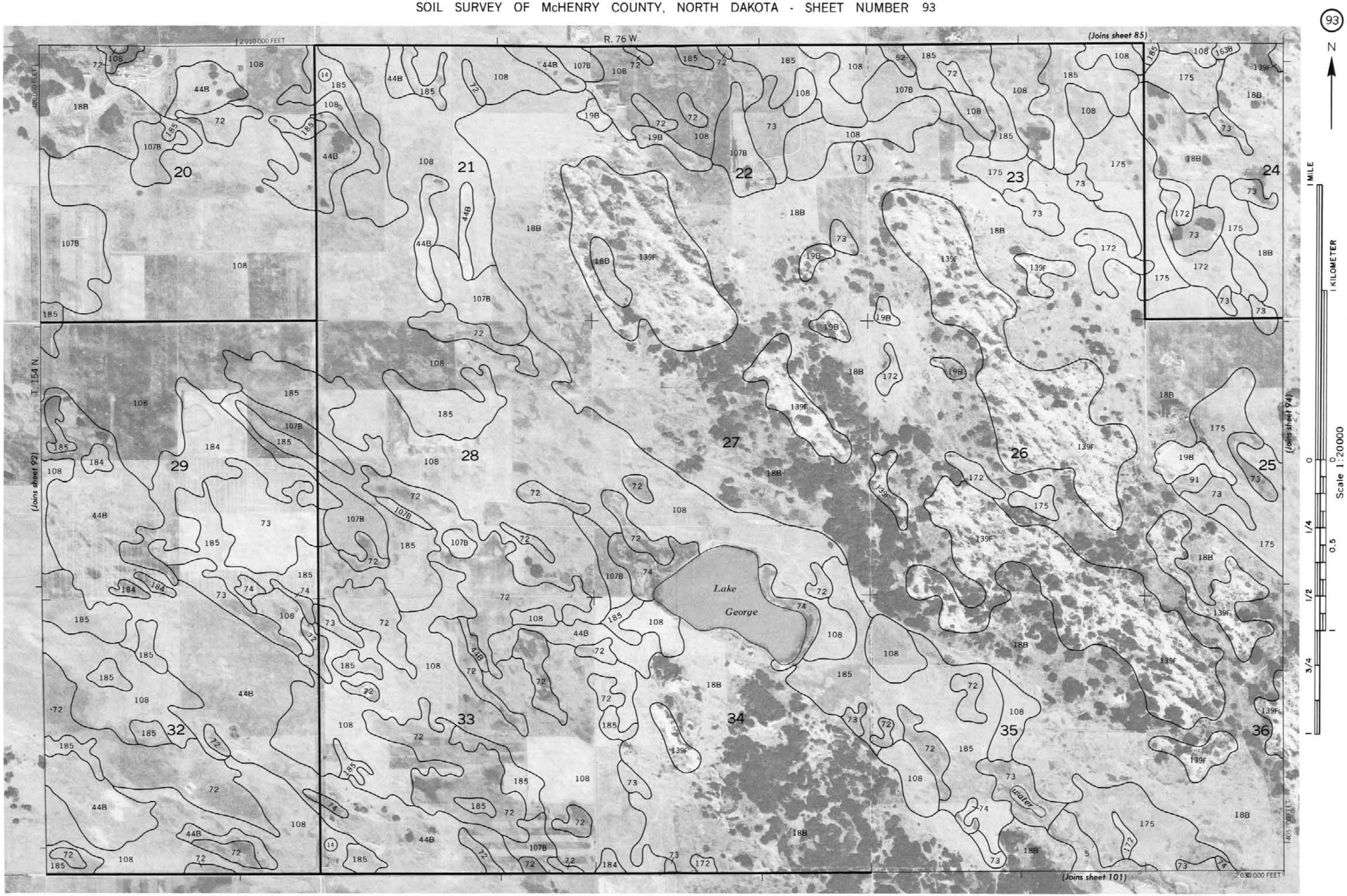


McHENRY COUNTY, NORTH DAKOTA NO. 91

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



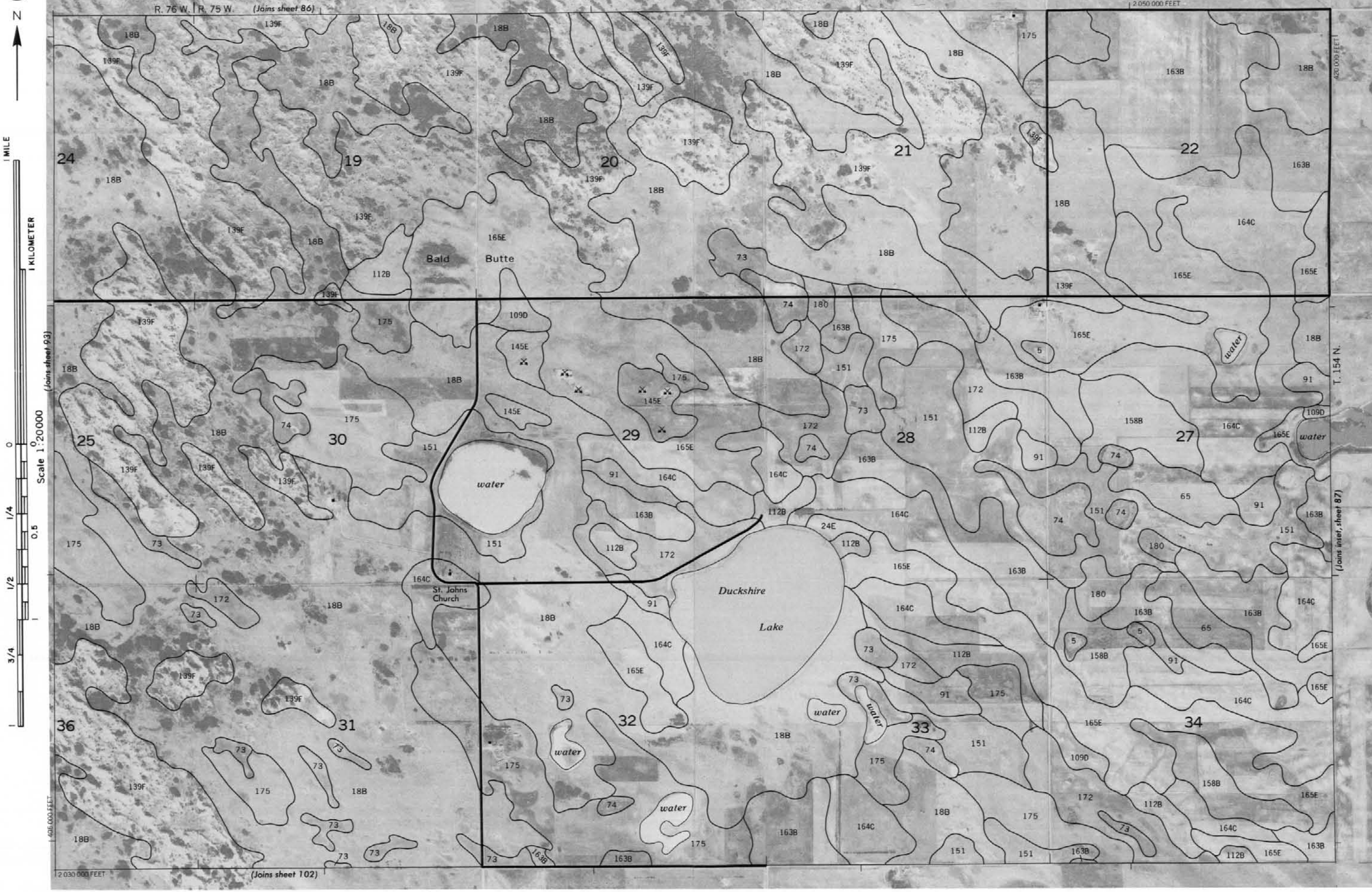
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 93

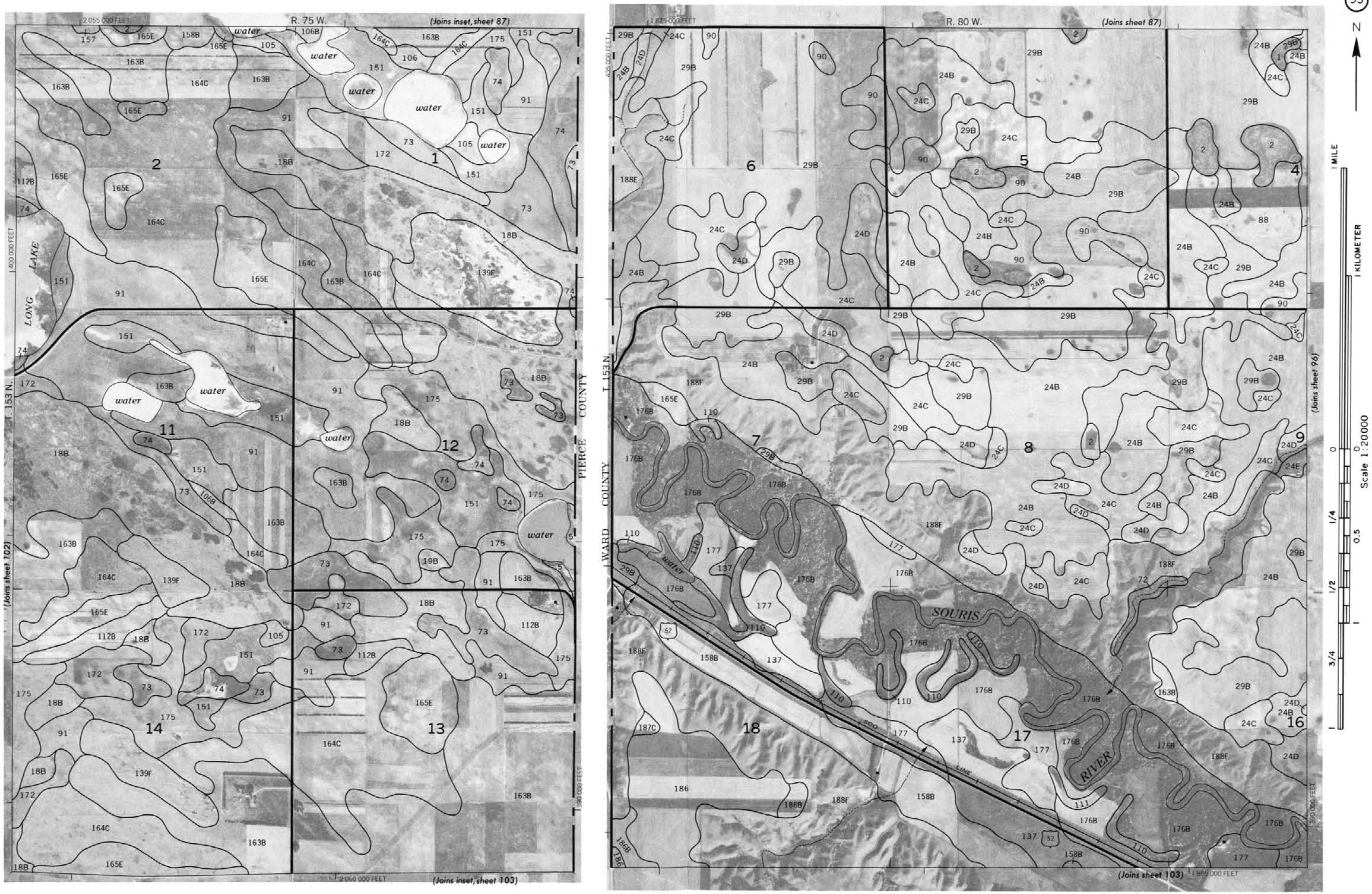
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 94



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 94



McHENRY COUNTY, NORTH DAKOTA NO. 95

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

96

N

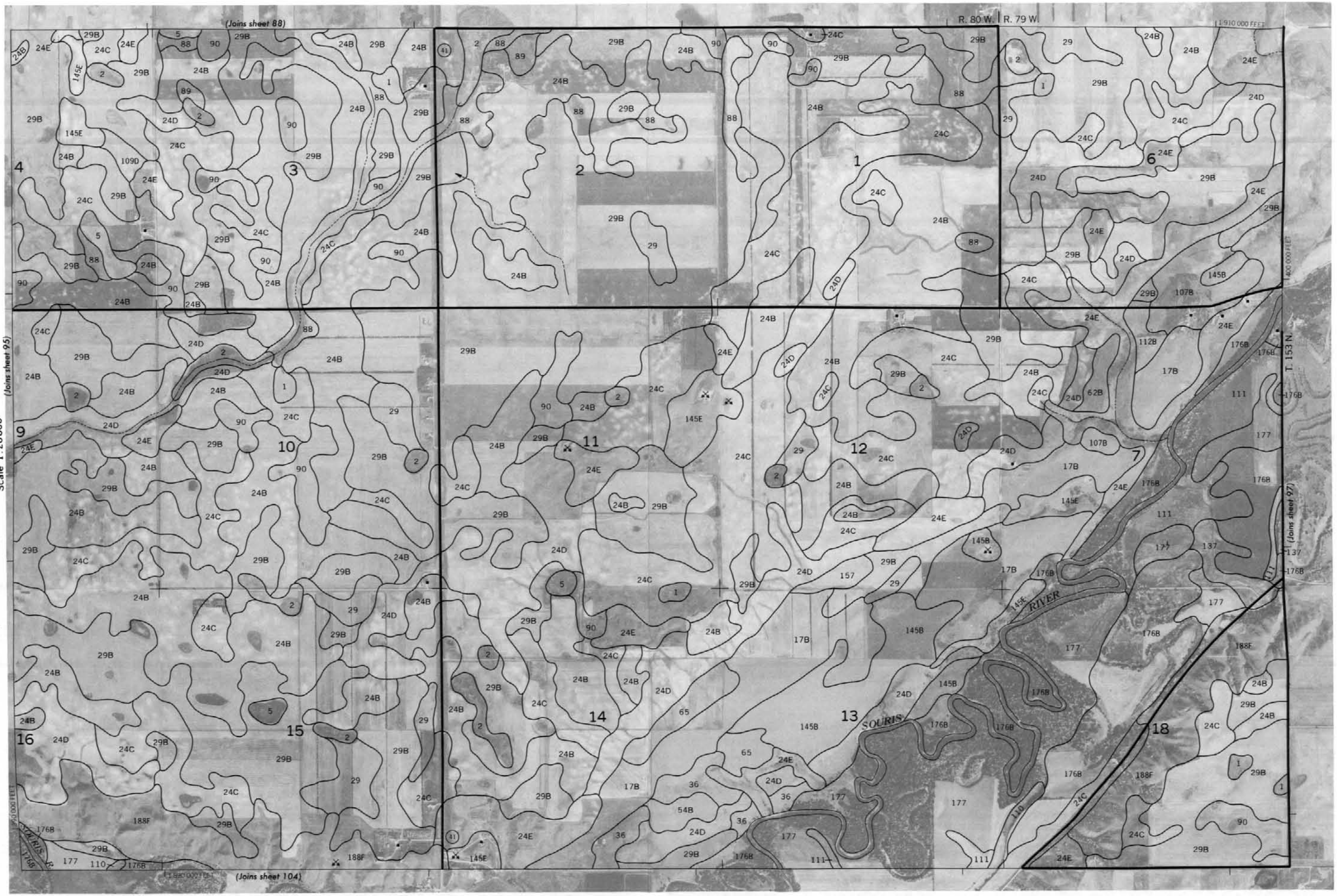
1 MILE

1 KILOMETER

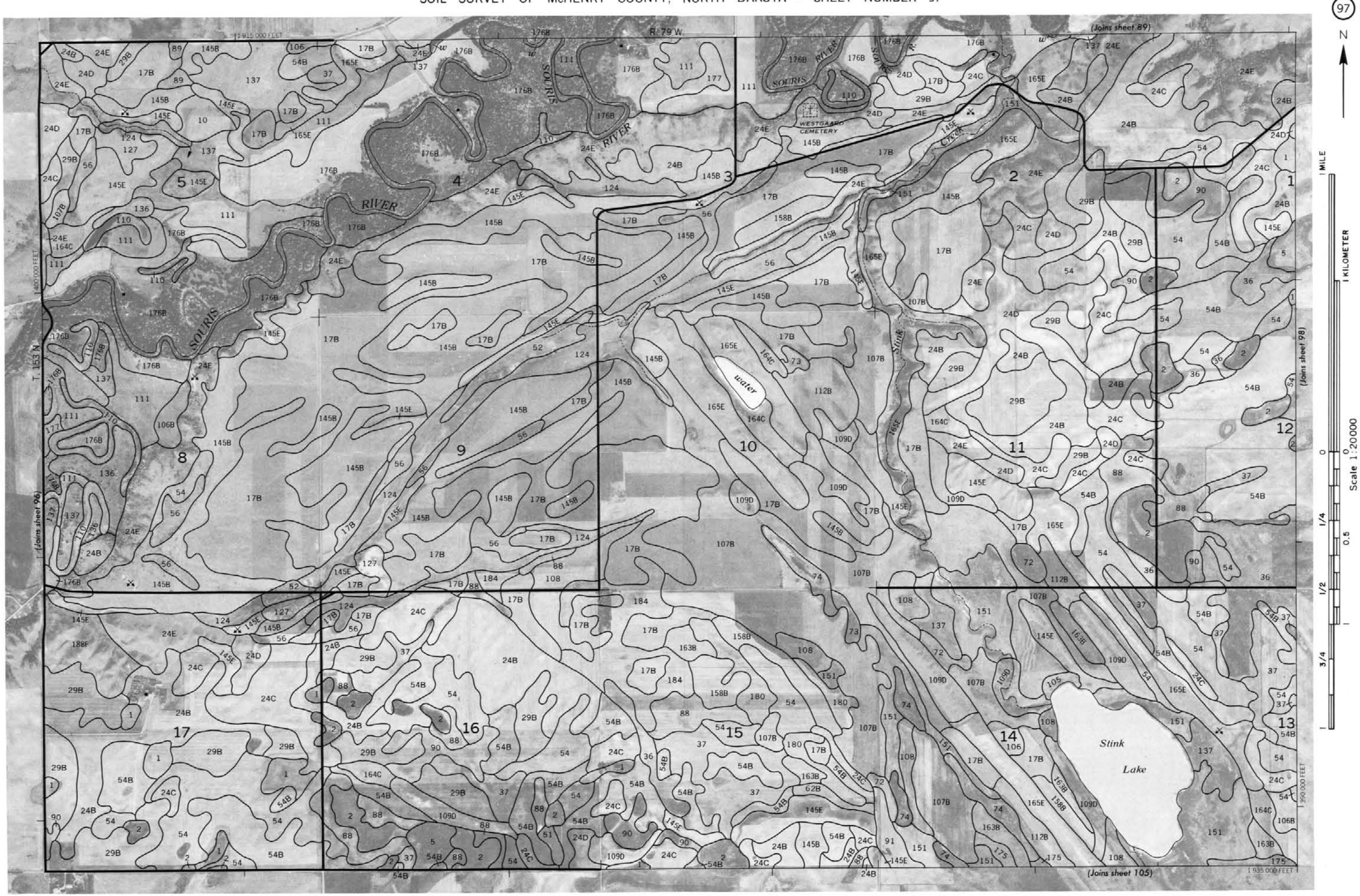
Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

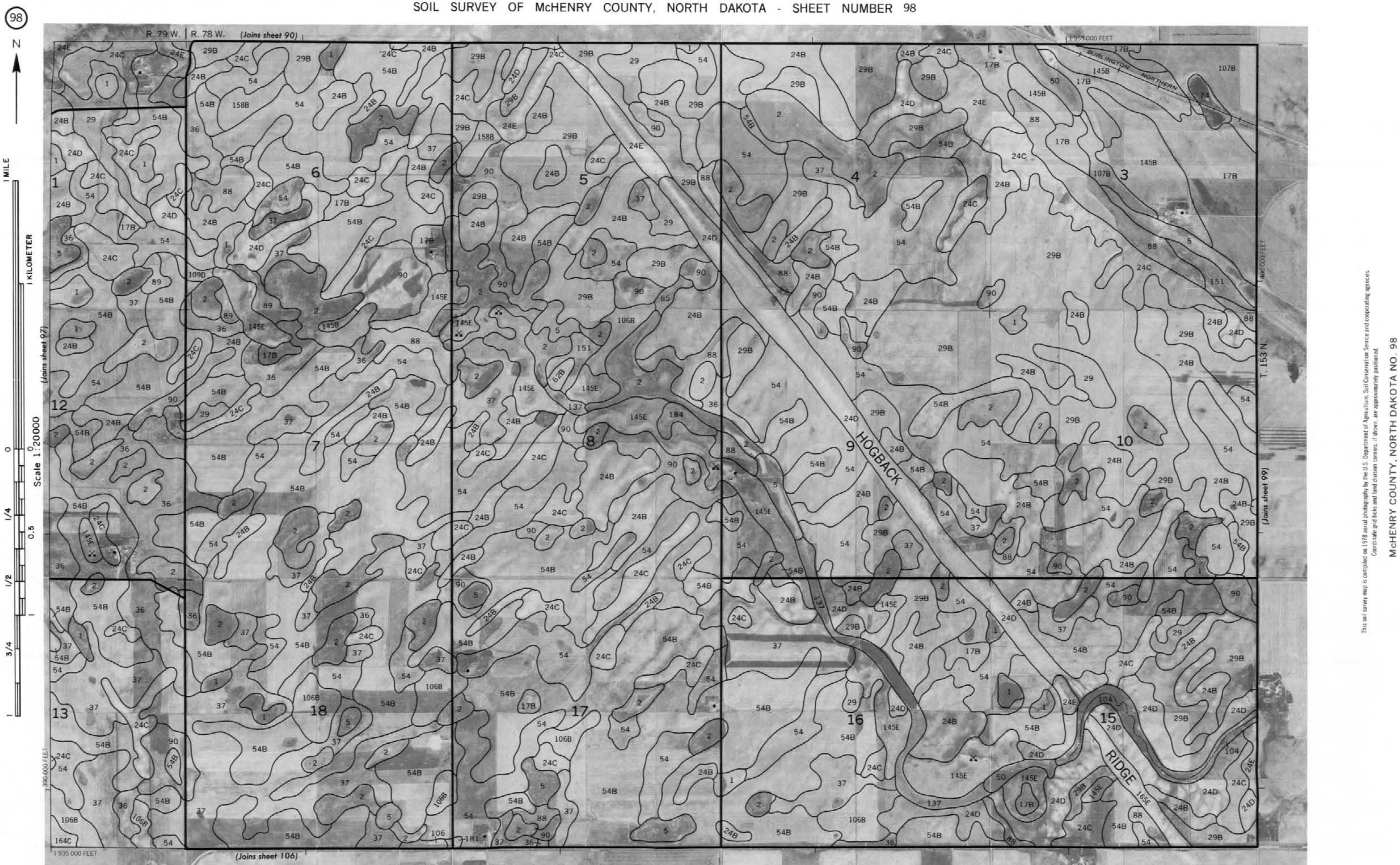


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



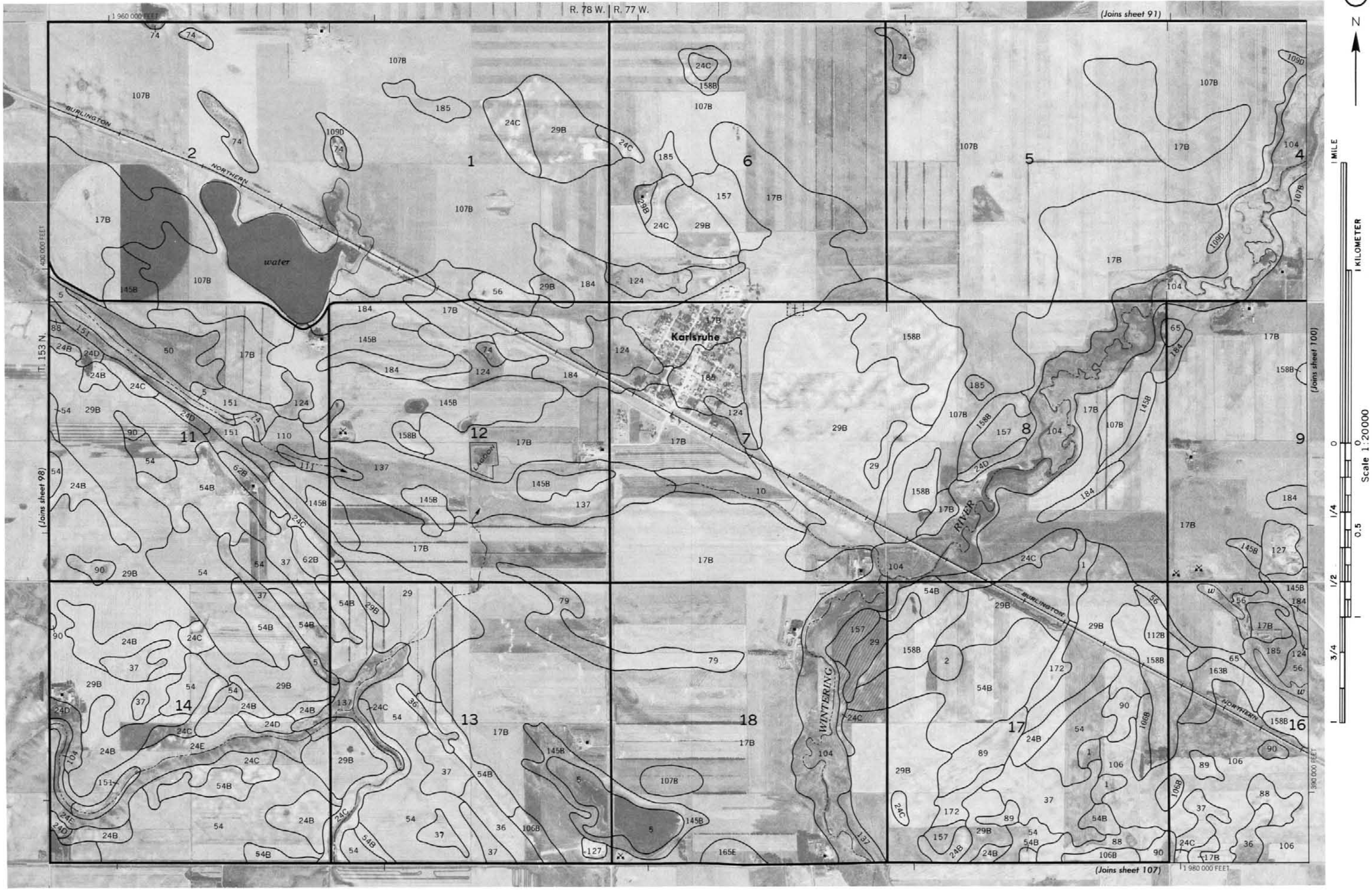
McHENRY COUNTY, NORTH DAKOTA NO. 97

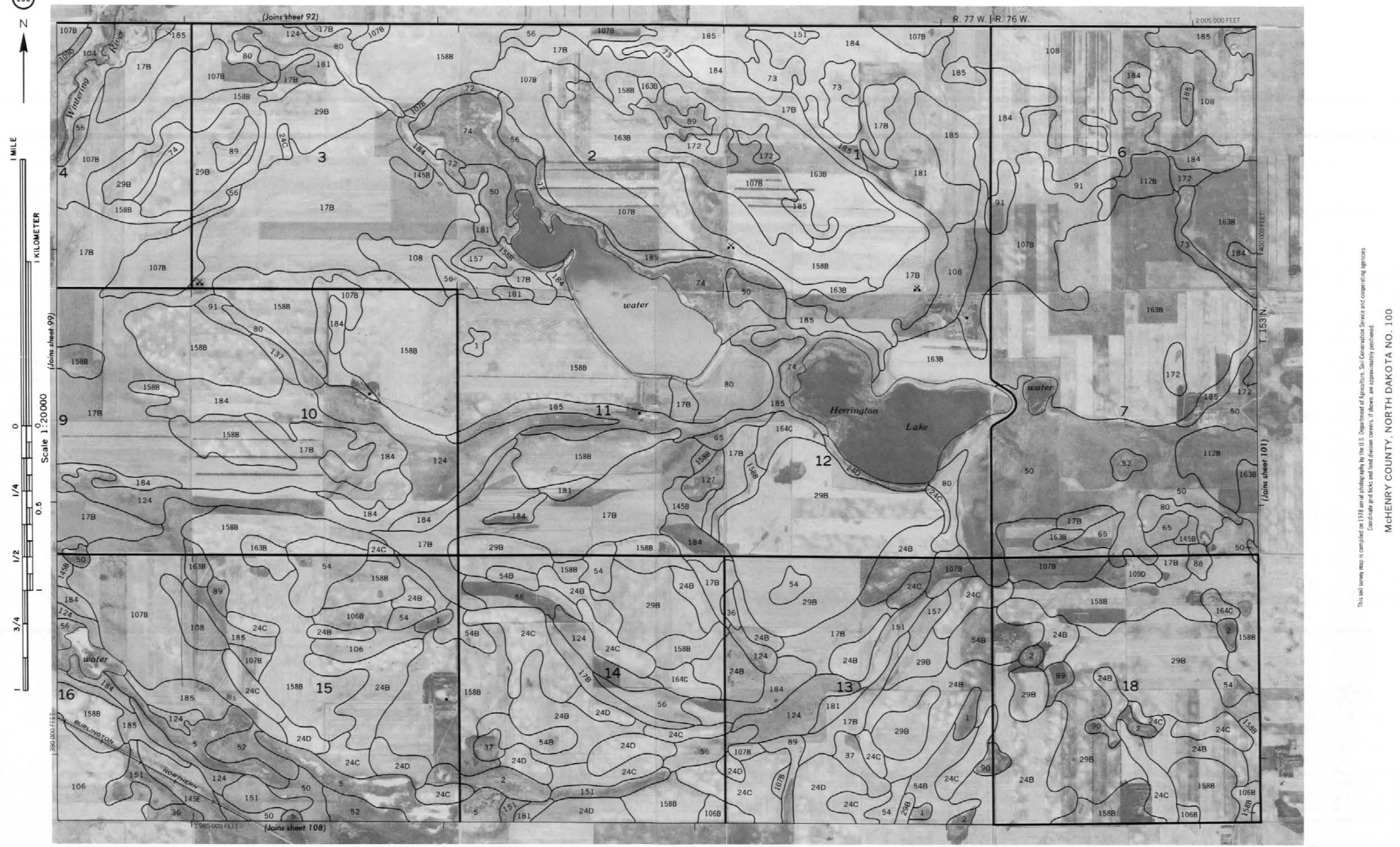
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


98
N
R. 79 W. | R. 78 W.
(Joins sheet 90)
(Joins sheet 97)
(Joins sheet 99)
(Joins sheet 106)
T. 153 N.
HOGBACK
RIDGE
BURLINGTON NORTHERN
1 955 000 FEET
1 935 000 FEET
400 000 FEET
390 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
McHENRY COUNTY, NORTH DAKOTA NO. 98

McHENRY COUNTY, NORTH DAKOTA NO. 99

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

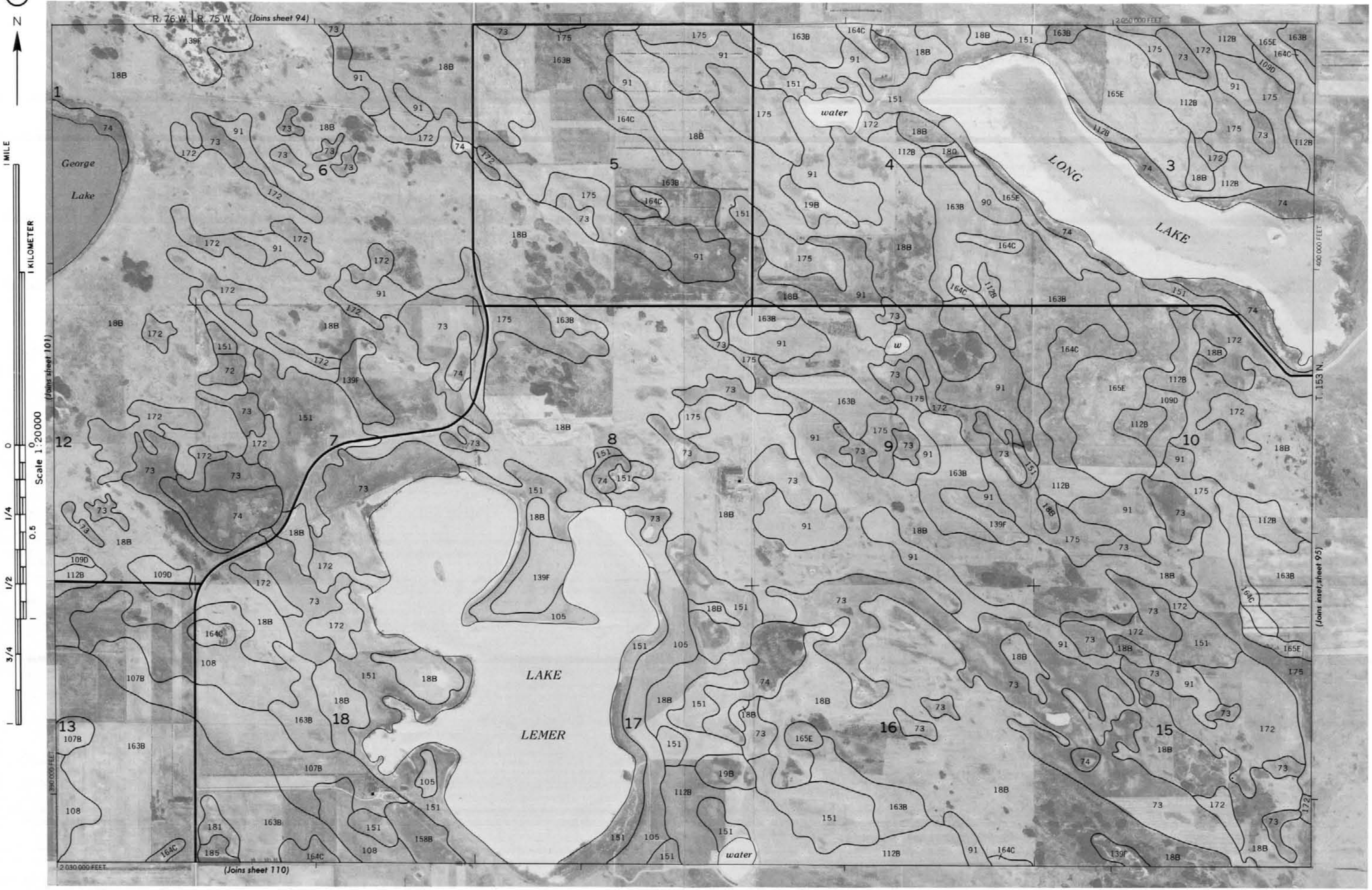



(Joins sheet 92)
(Joins sheet 99)
(Joins sheet 101)
(Joins sheet 108)
R. 77 W. | R. 76 W.
T. 153 N.
water
Herrington
Lake
Wintering
River
BURLINGTON
NORTHERN
N
1 MILE
1 KILOMETER
Scale 1:20000
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.
McHENRY COUNTY, NORTH DAKOTA NO. 100

McHENRY COUNTY, NORTH DAKOTA NO. 101

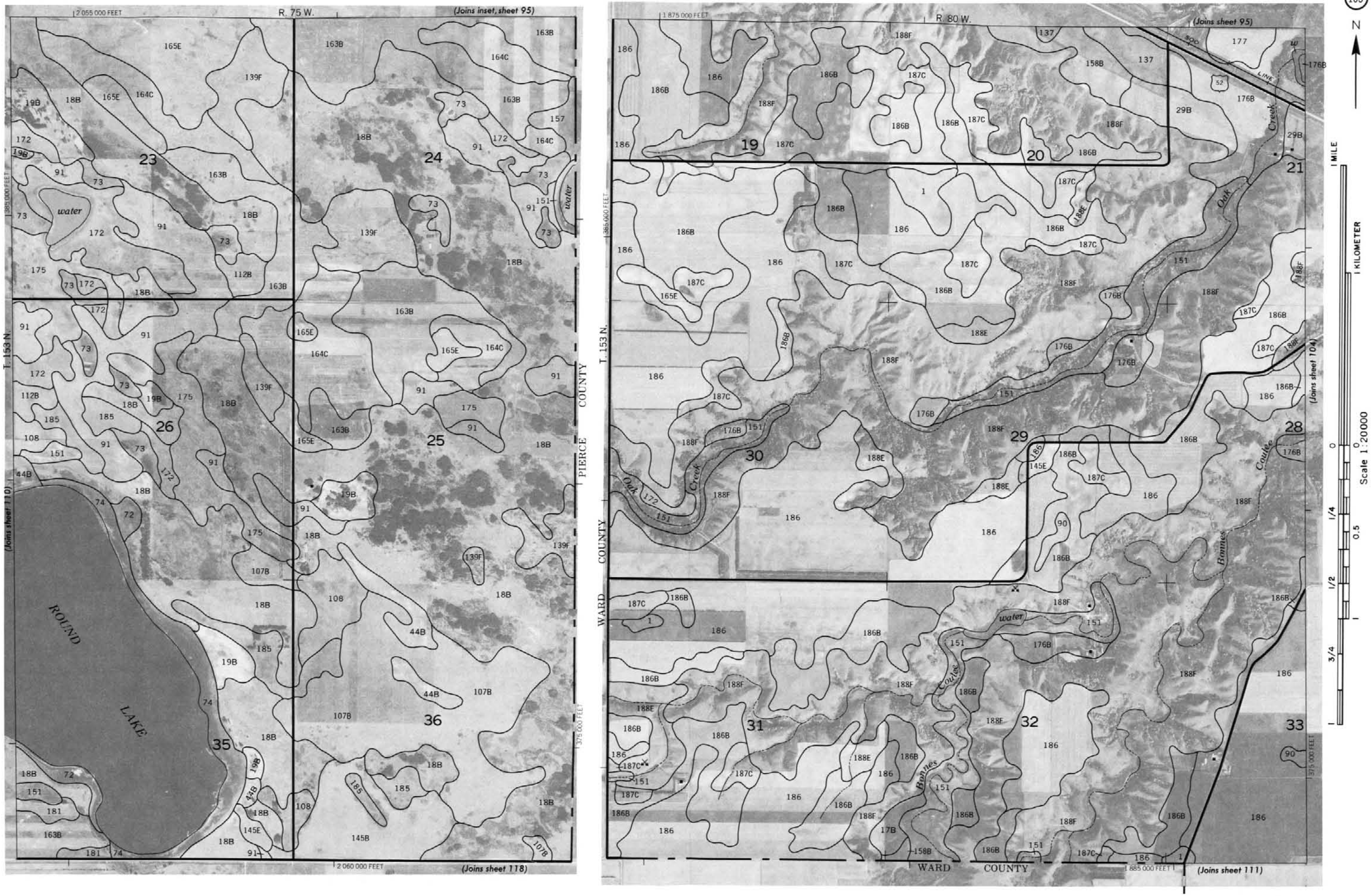
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 102



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

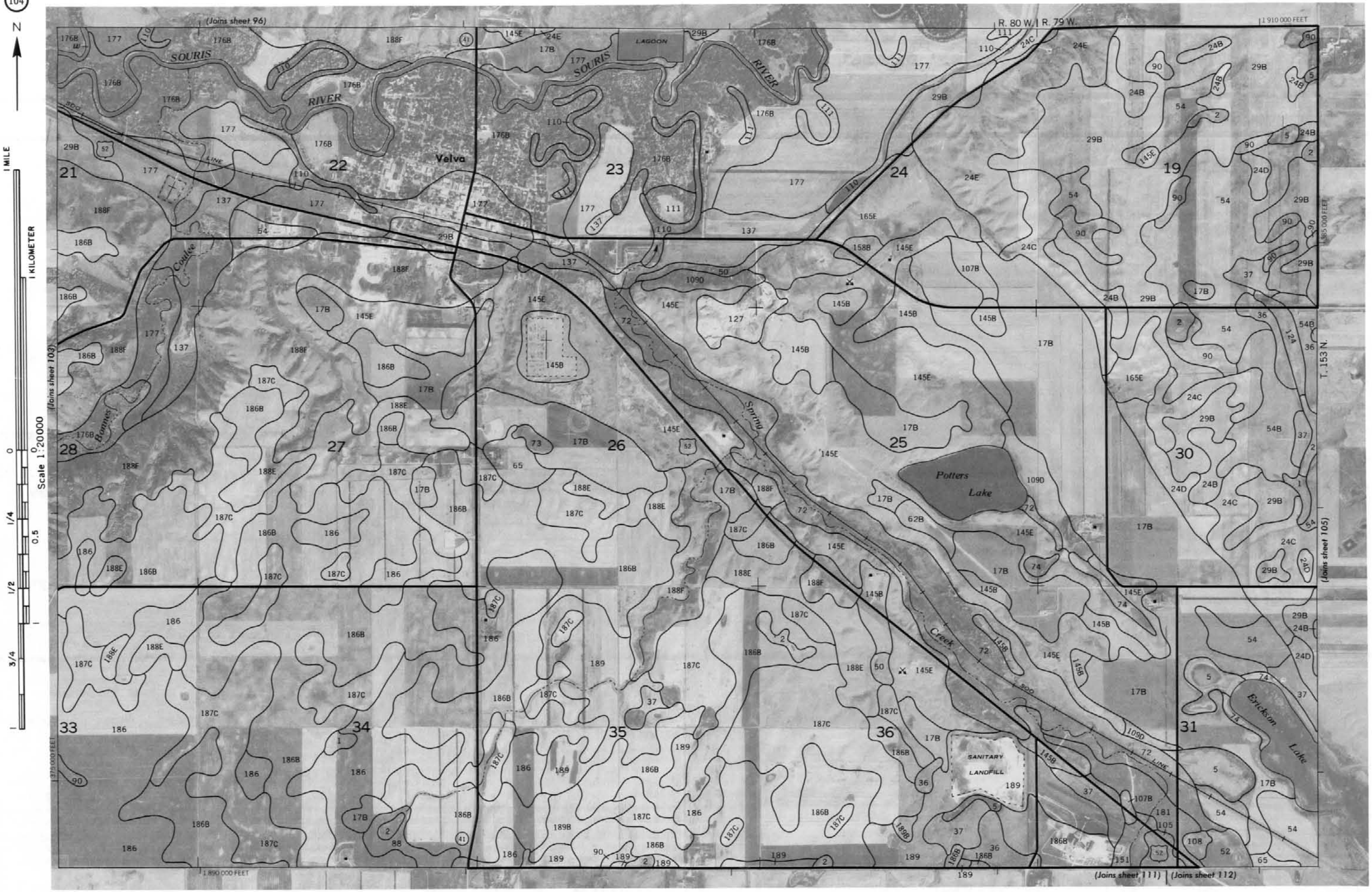
McHENRY COUNTY, NORTH DAKOTA NO. 102



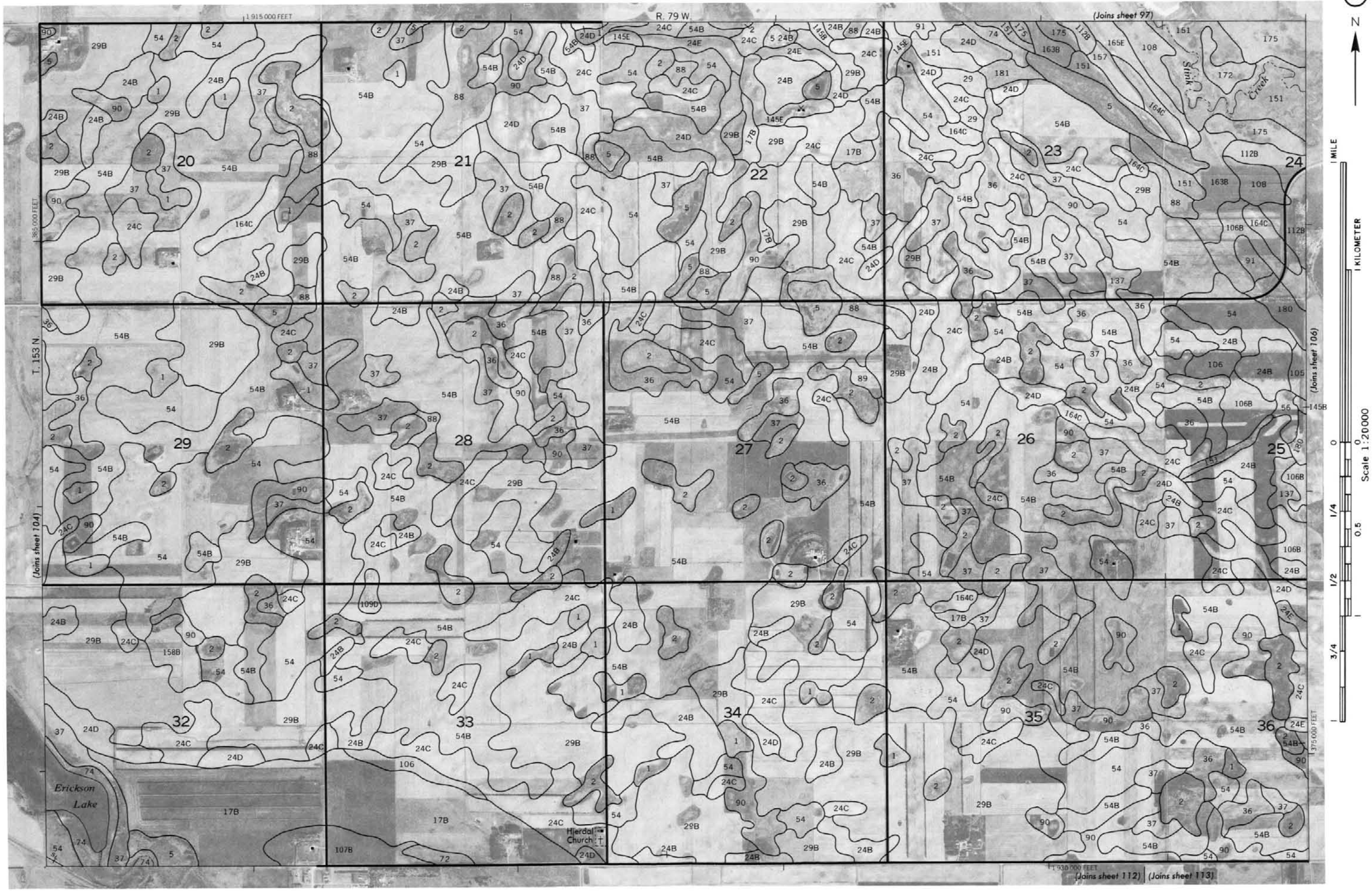
McHENRY COUNTY, NORTH DAKOTA NO. 103

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 104



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

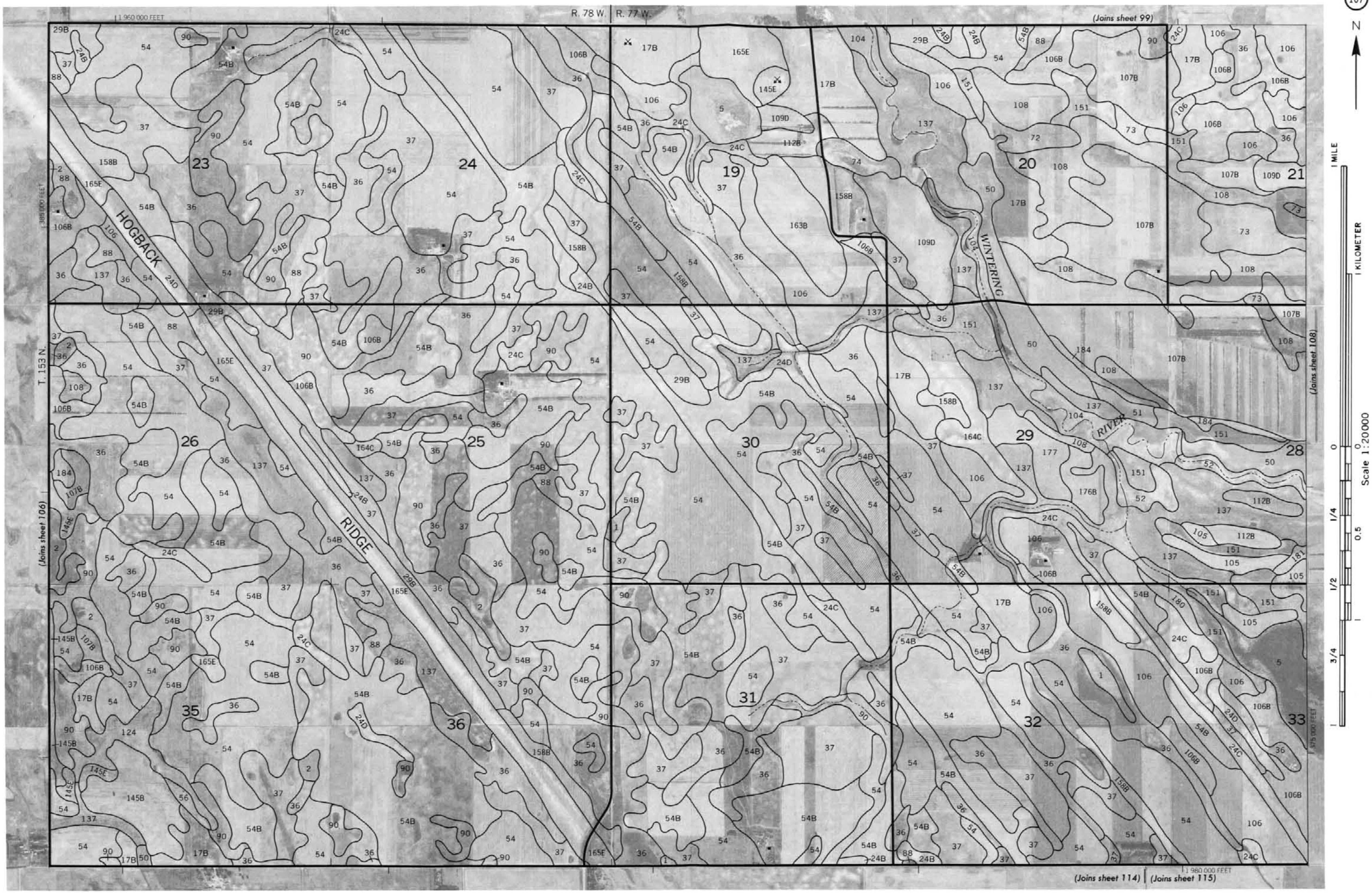


McHENRY COUNTY, NORTH DAKOTA NO. 105

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

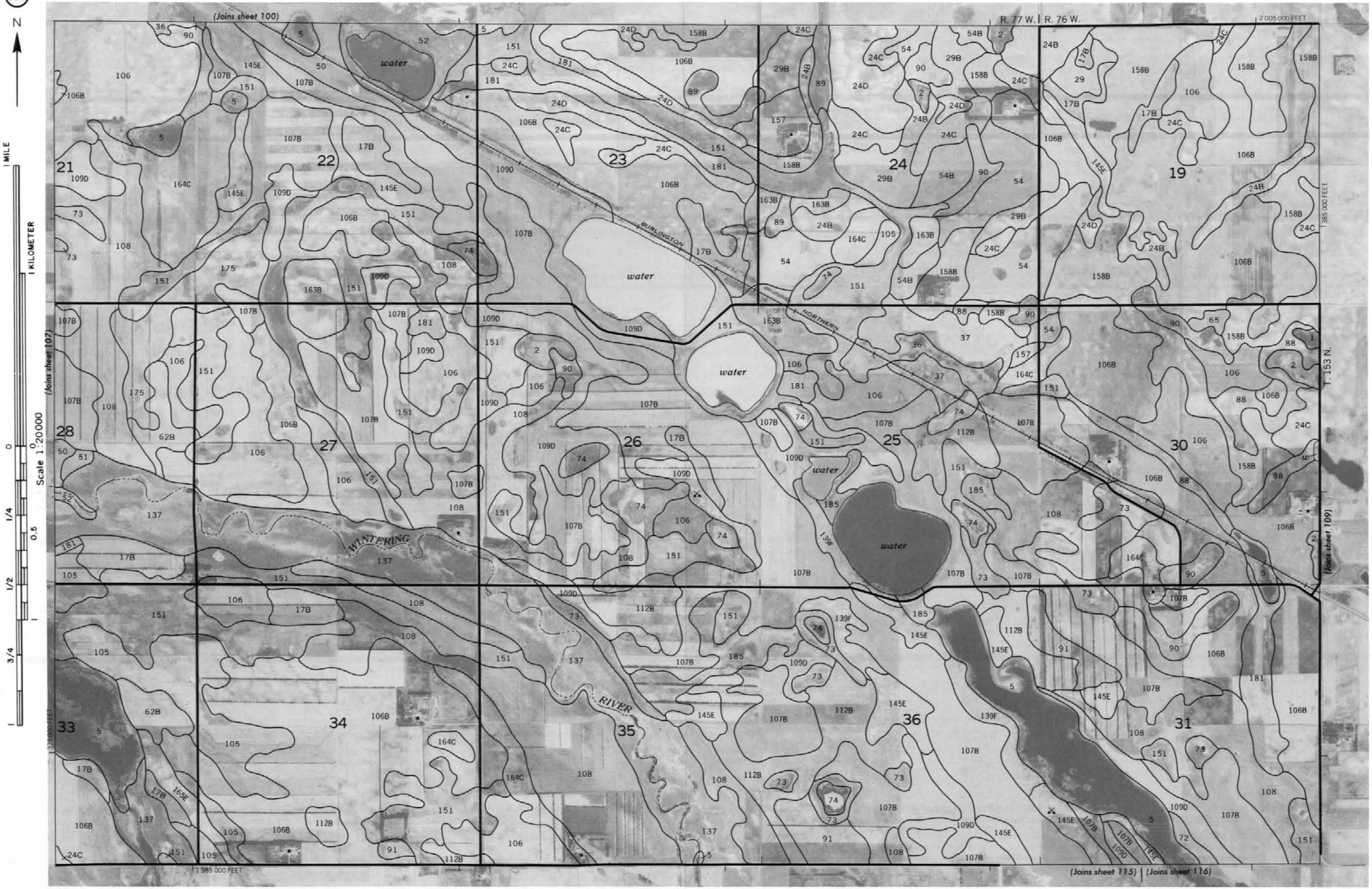
SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 106

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

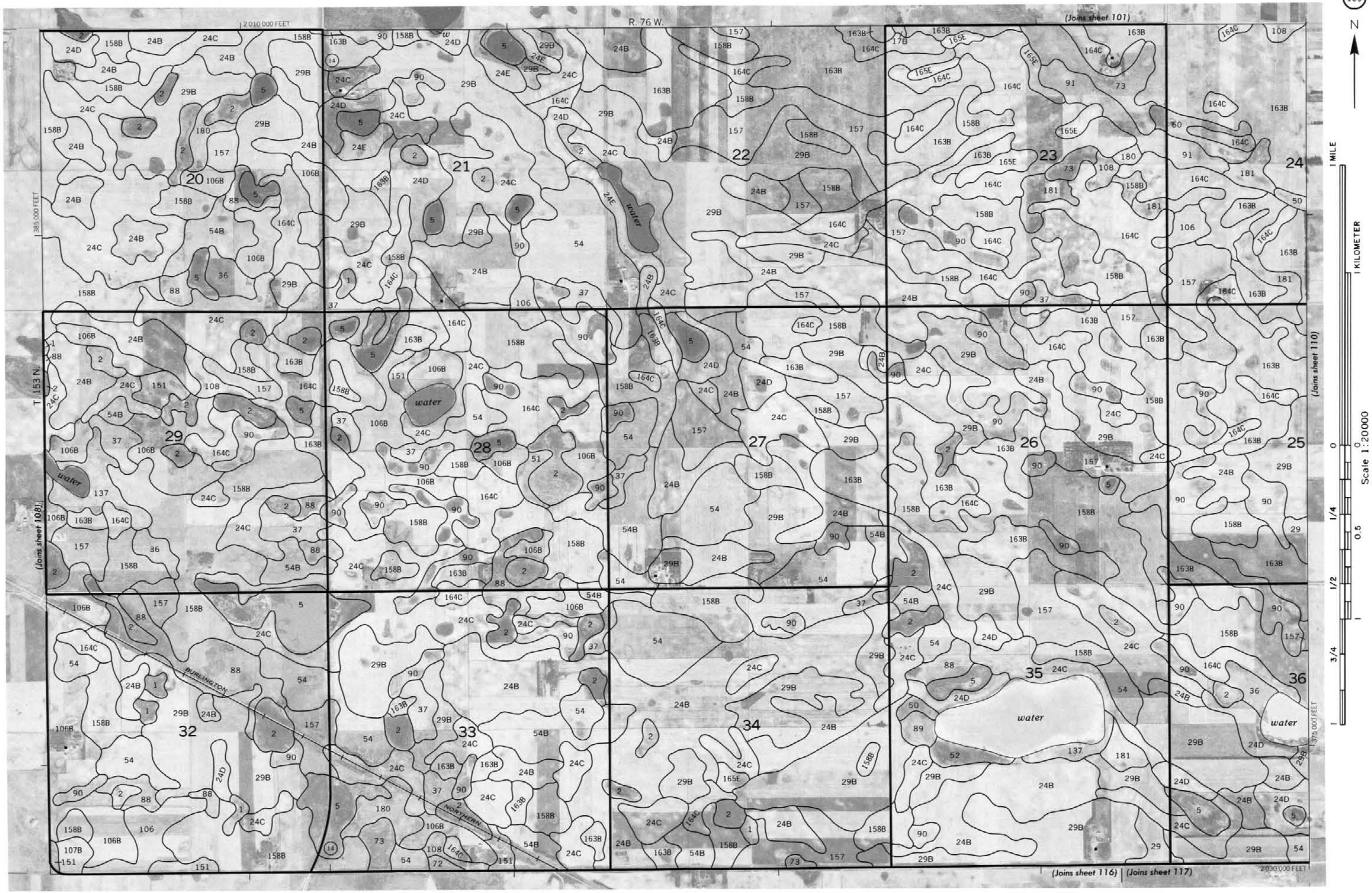


McHENRY COUNTY, NORTH DAKOTA NO. 107

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



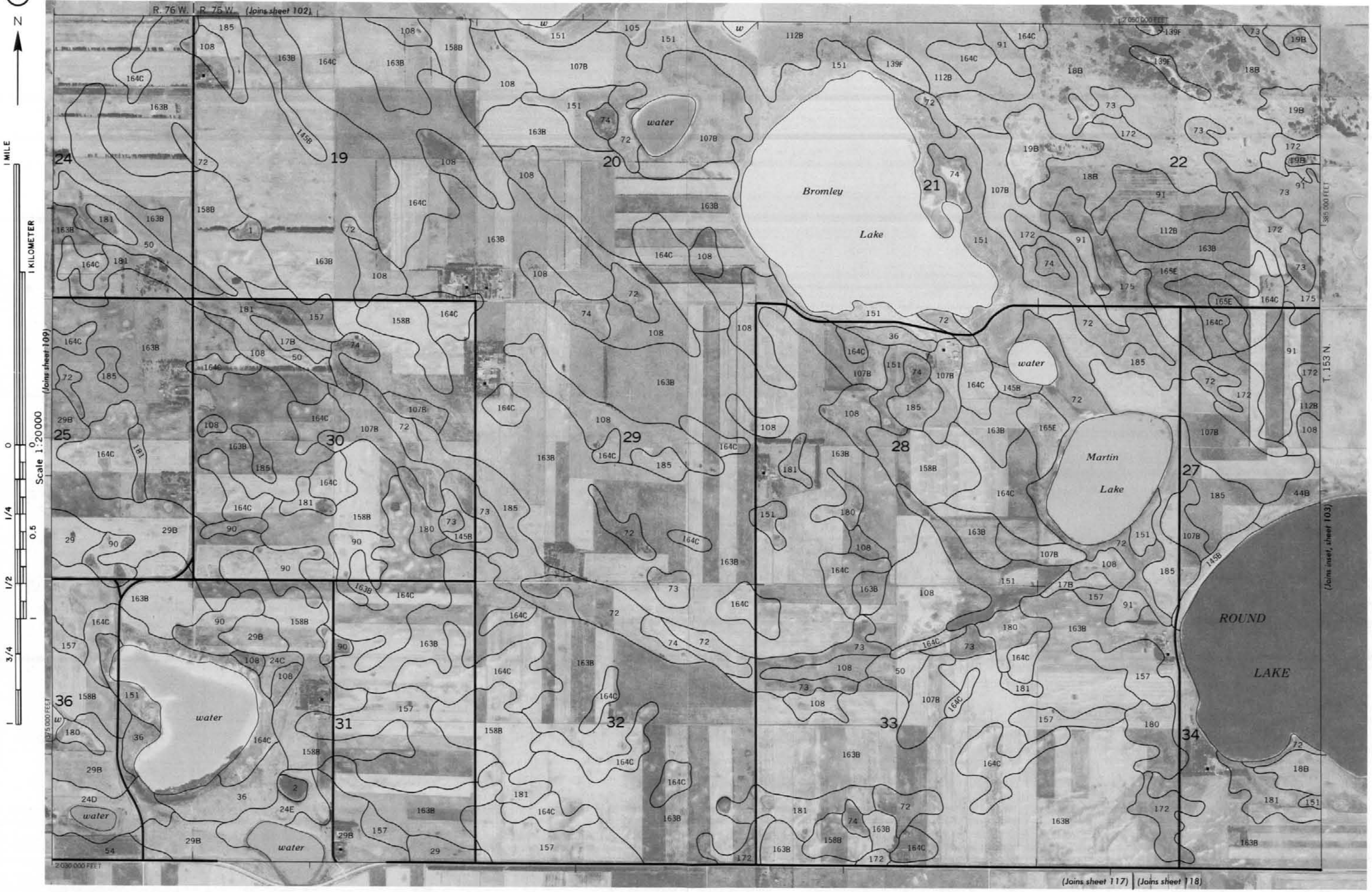
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 109

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 110

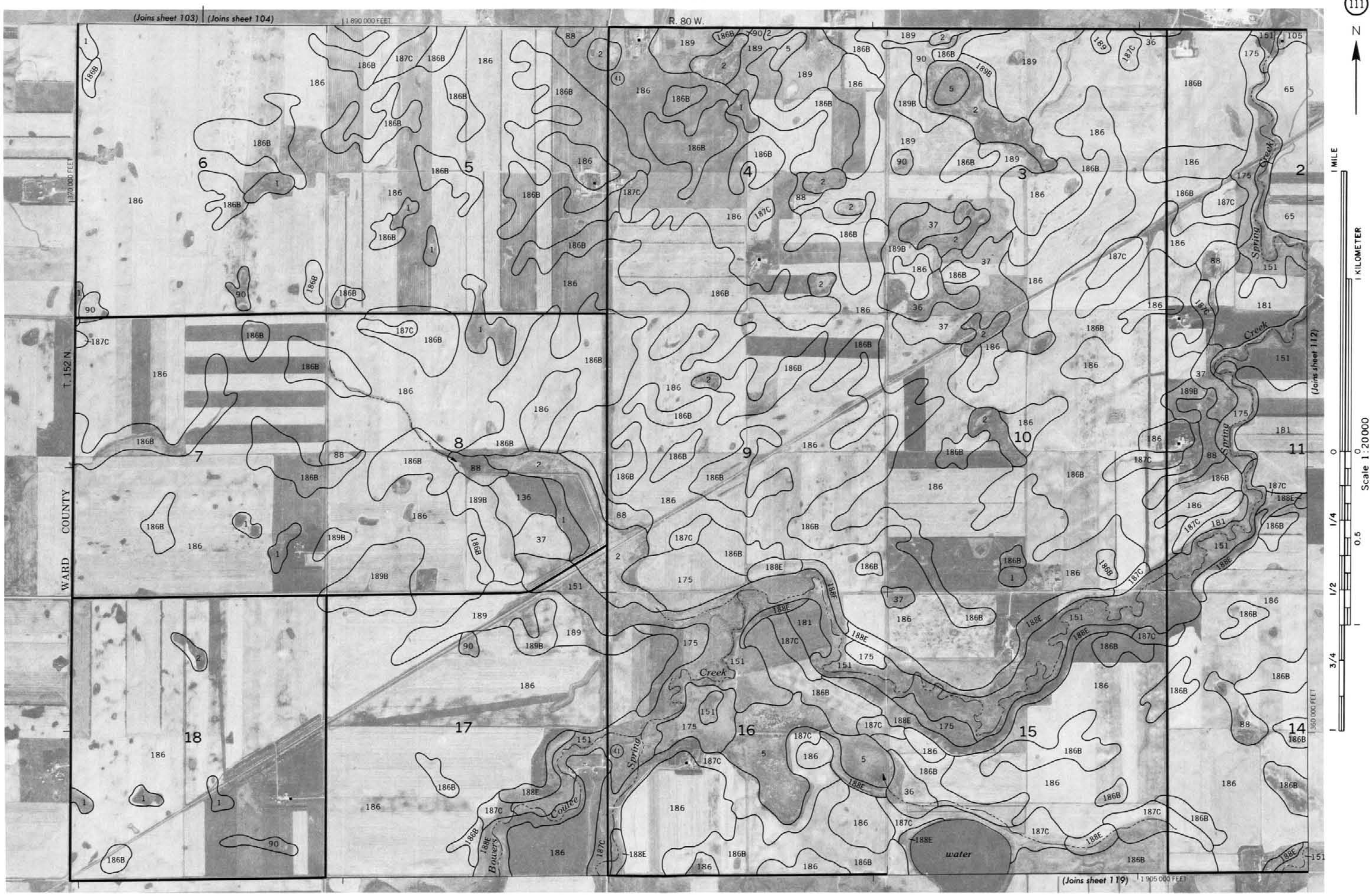


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 110

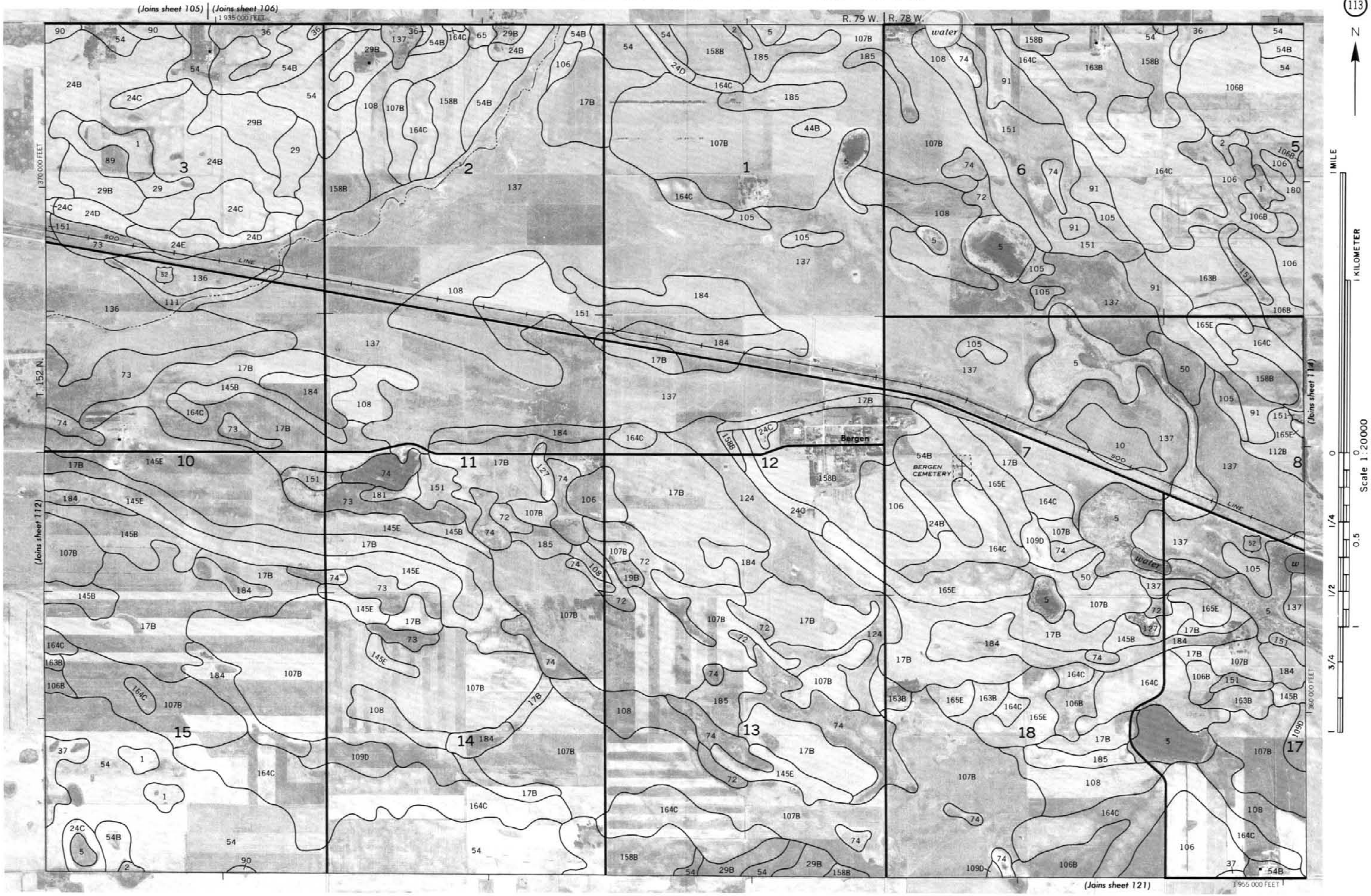
McHENRY COUNTY, NORTH DAKOTA NO. 111

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



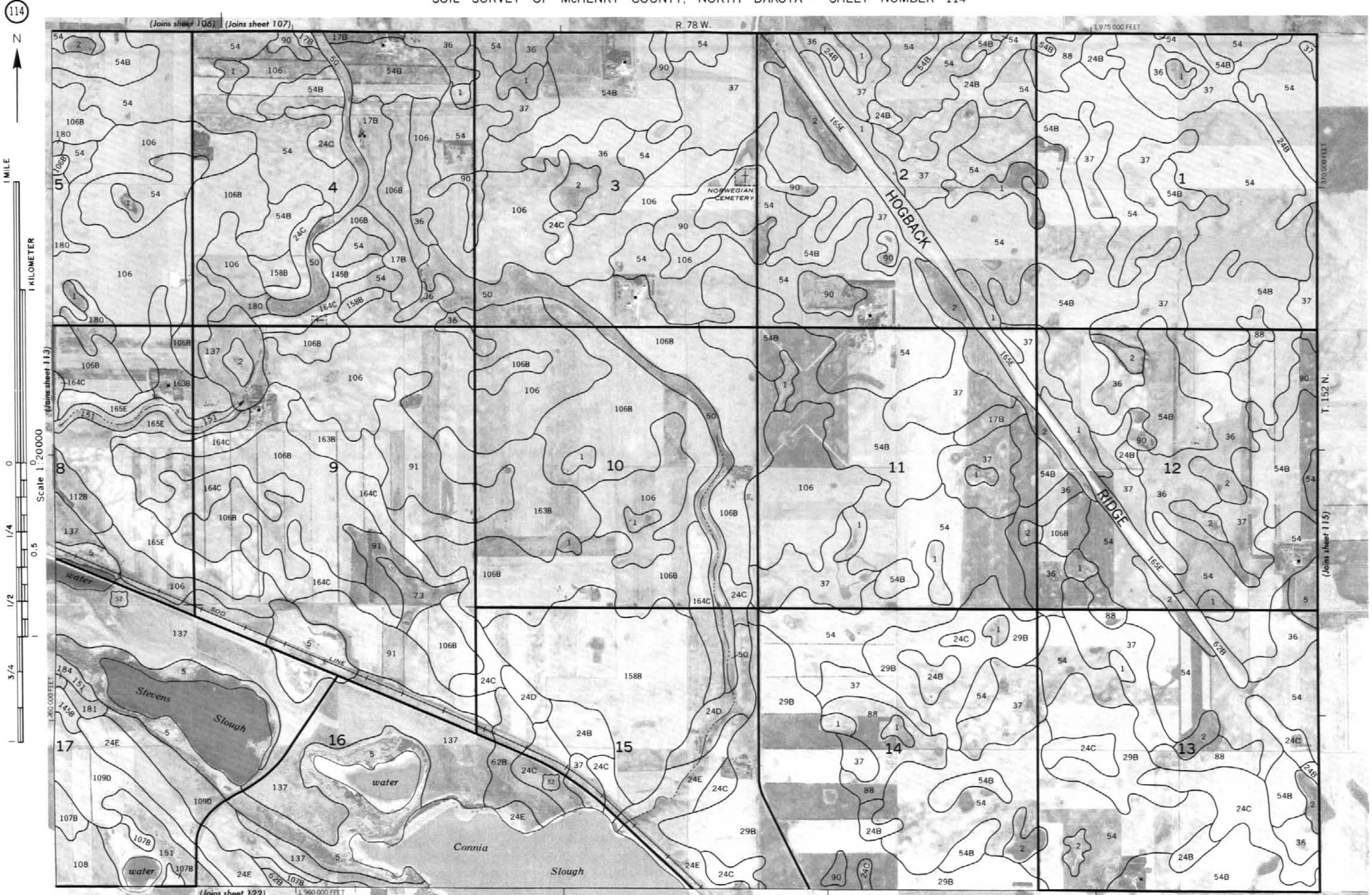
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

113



McHENRY COUNTY, NORTH DAKOTA NO. 113

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

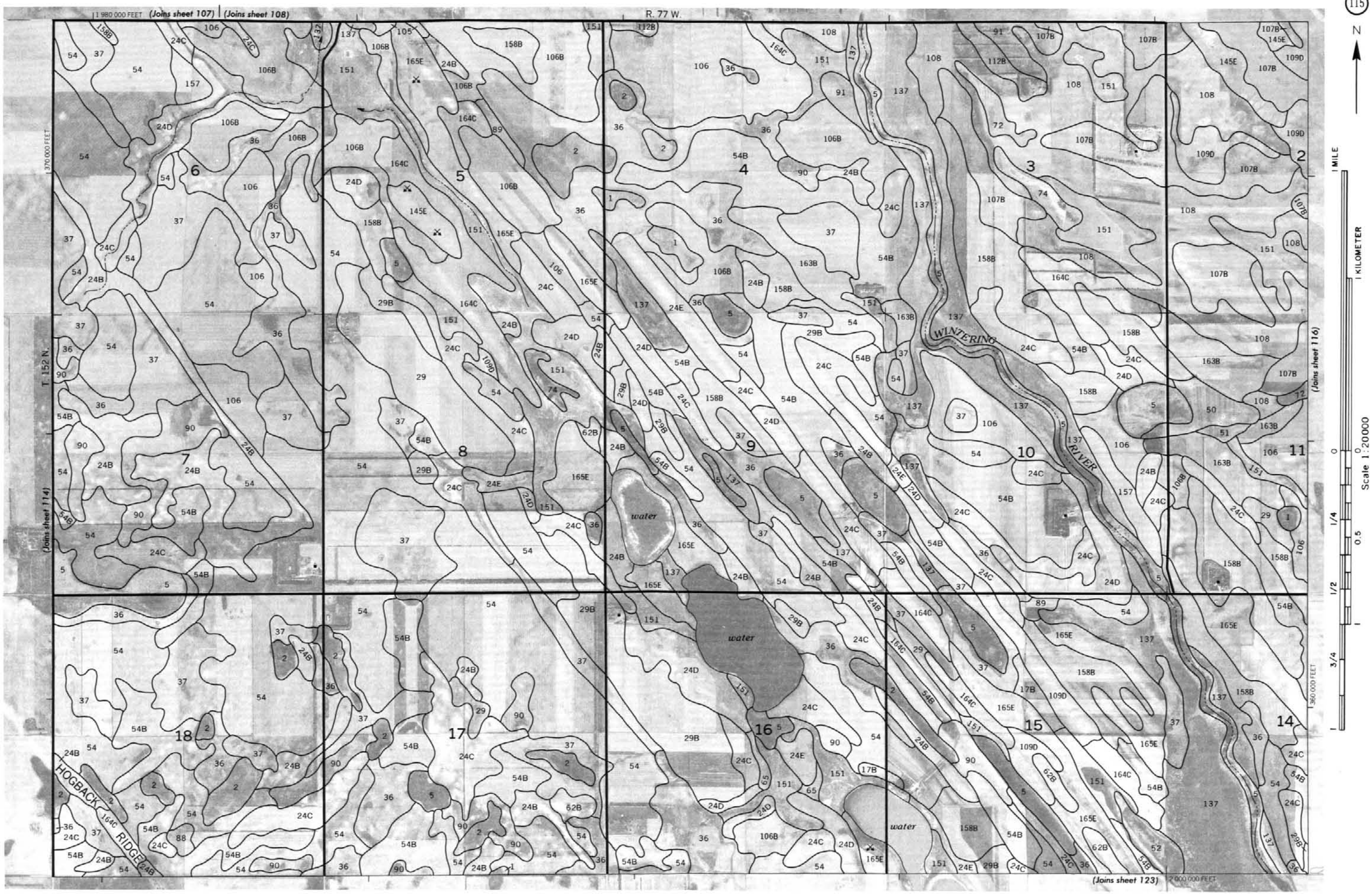


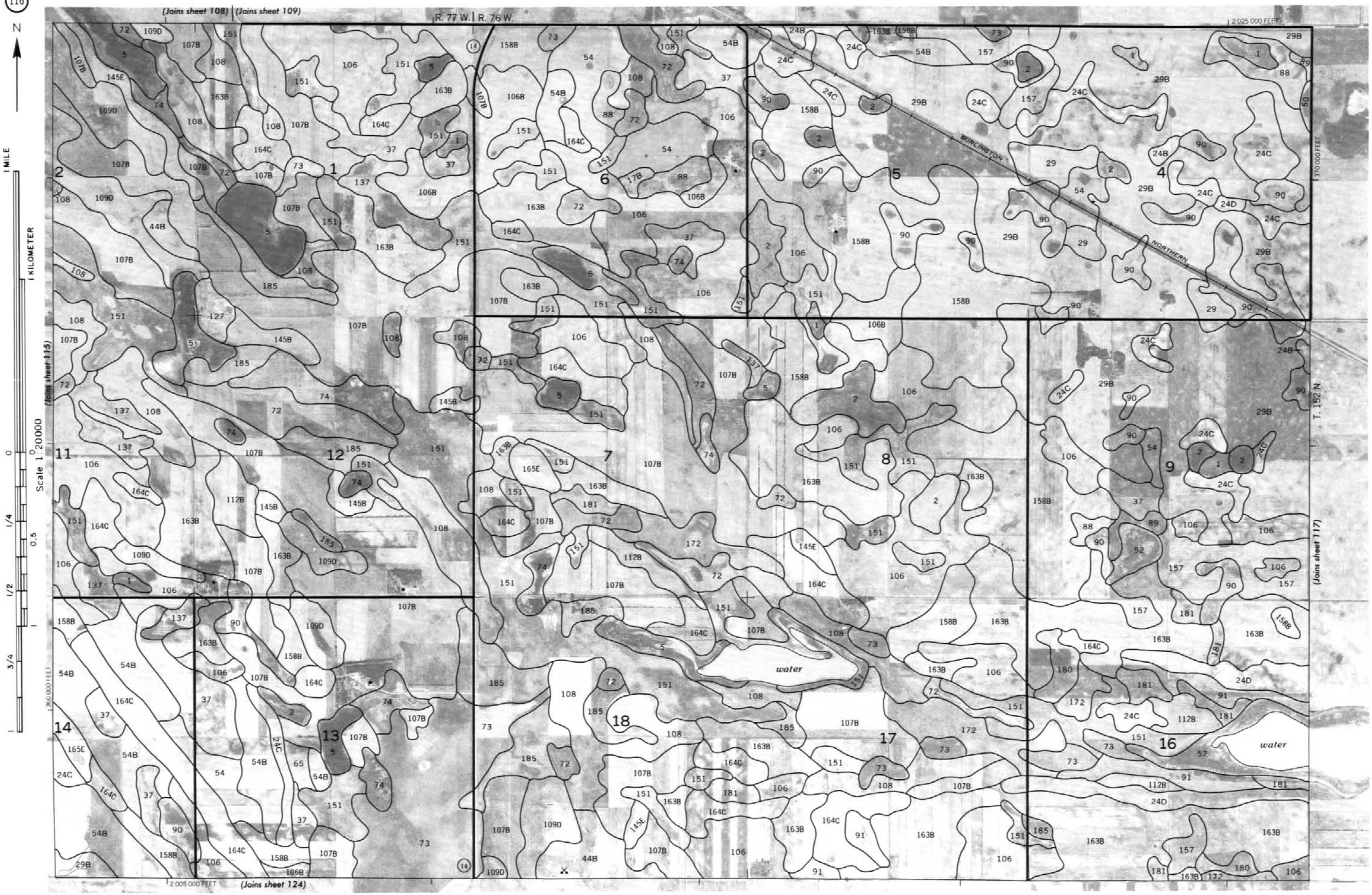
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 114

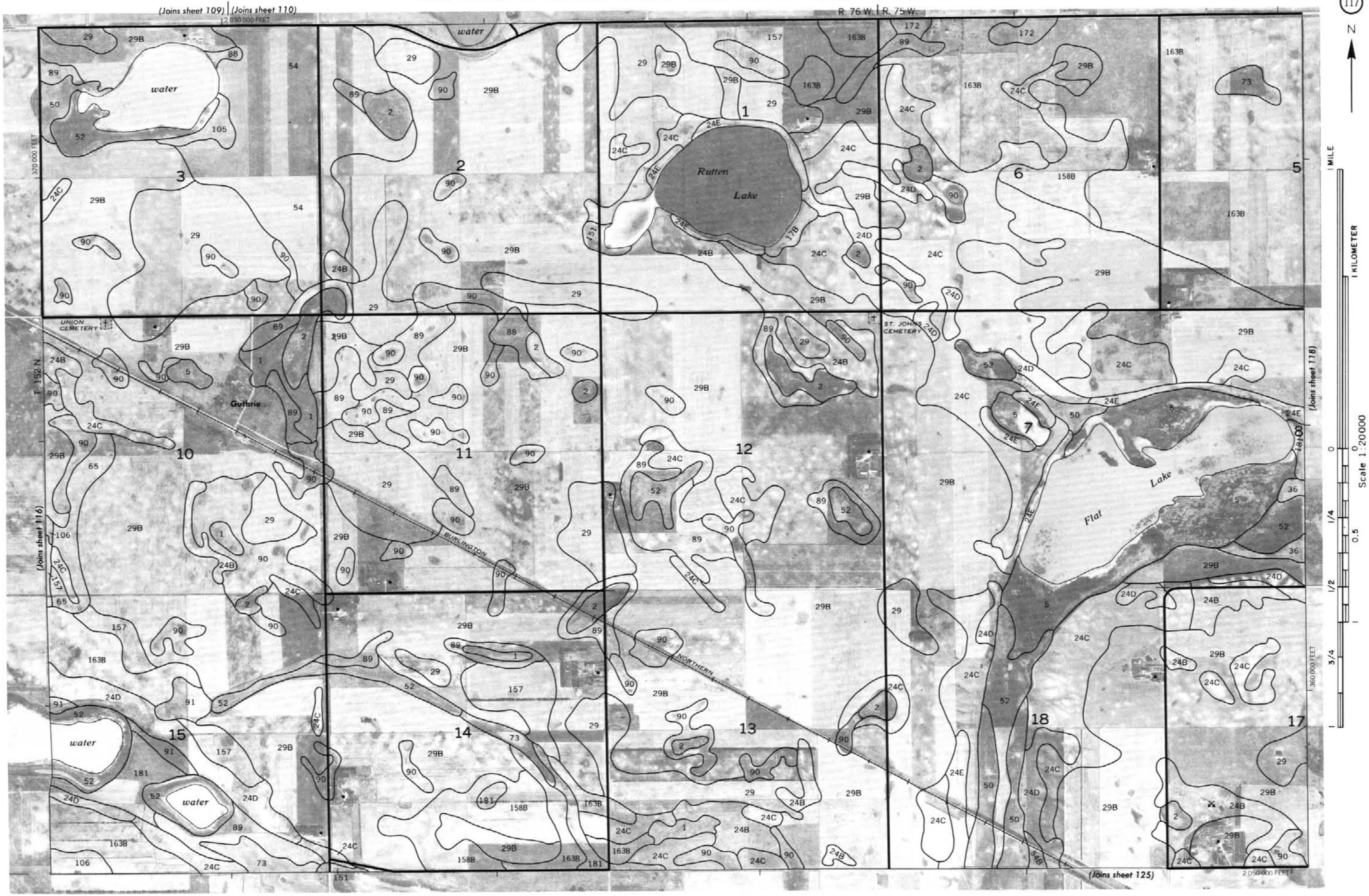
McHENRY COUNTY, NORTH DAKOTA NO. 115

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



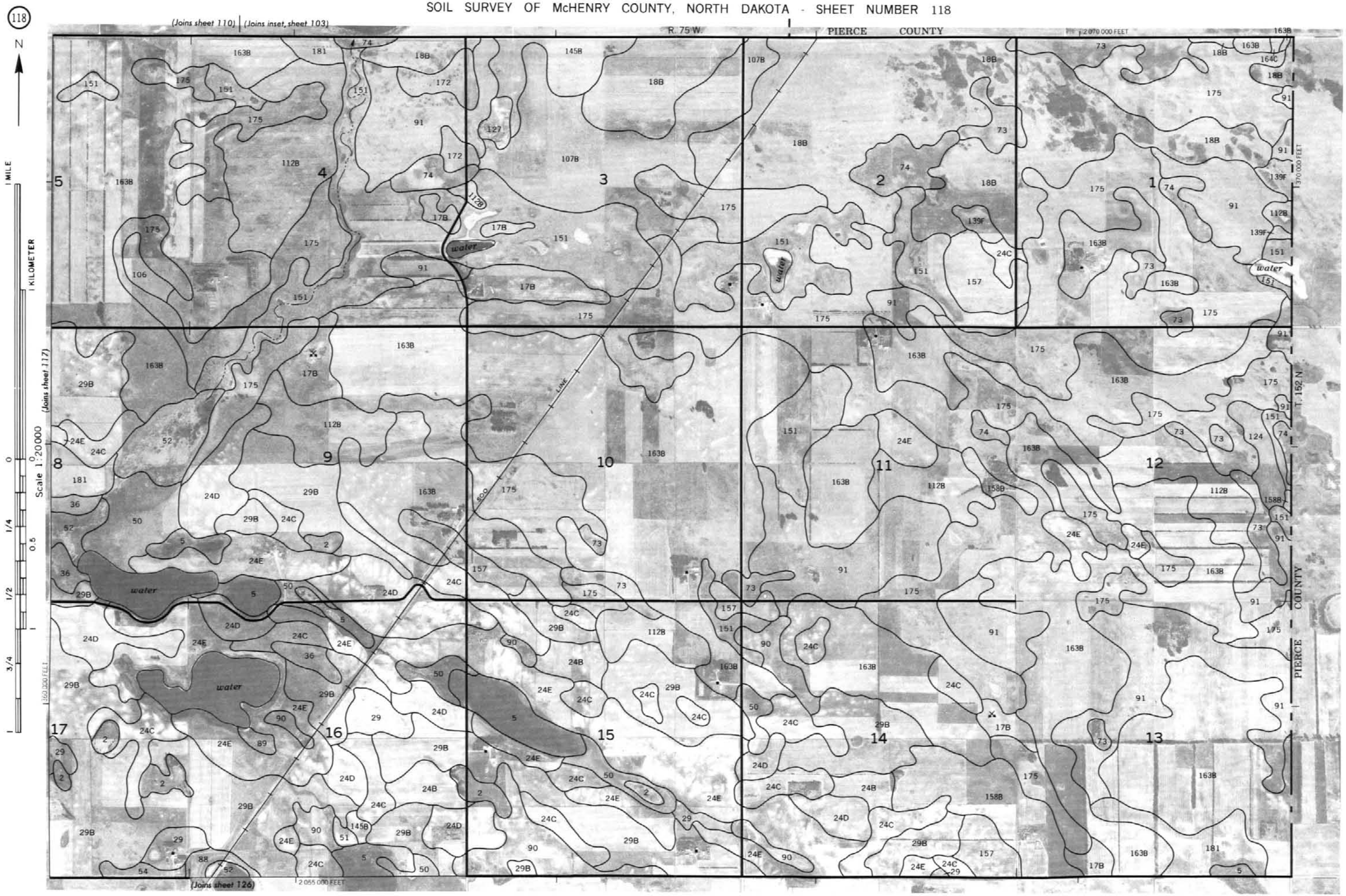


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

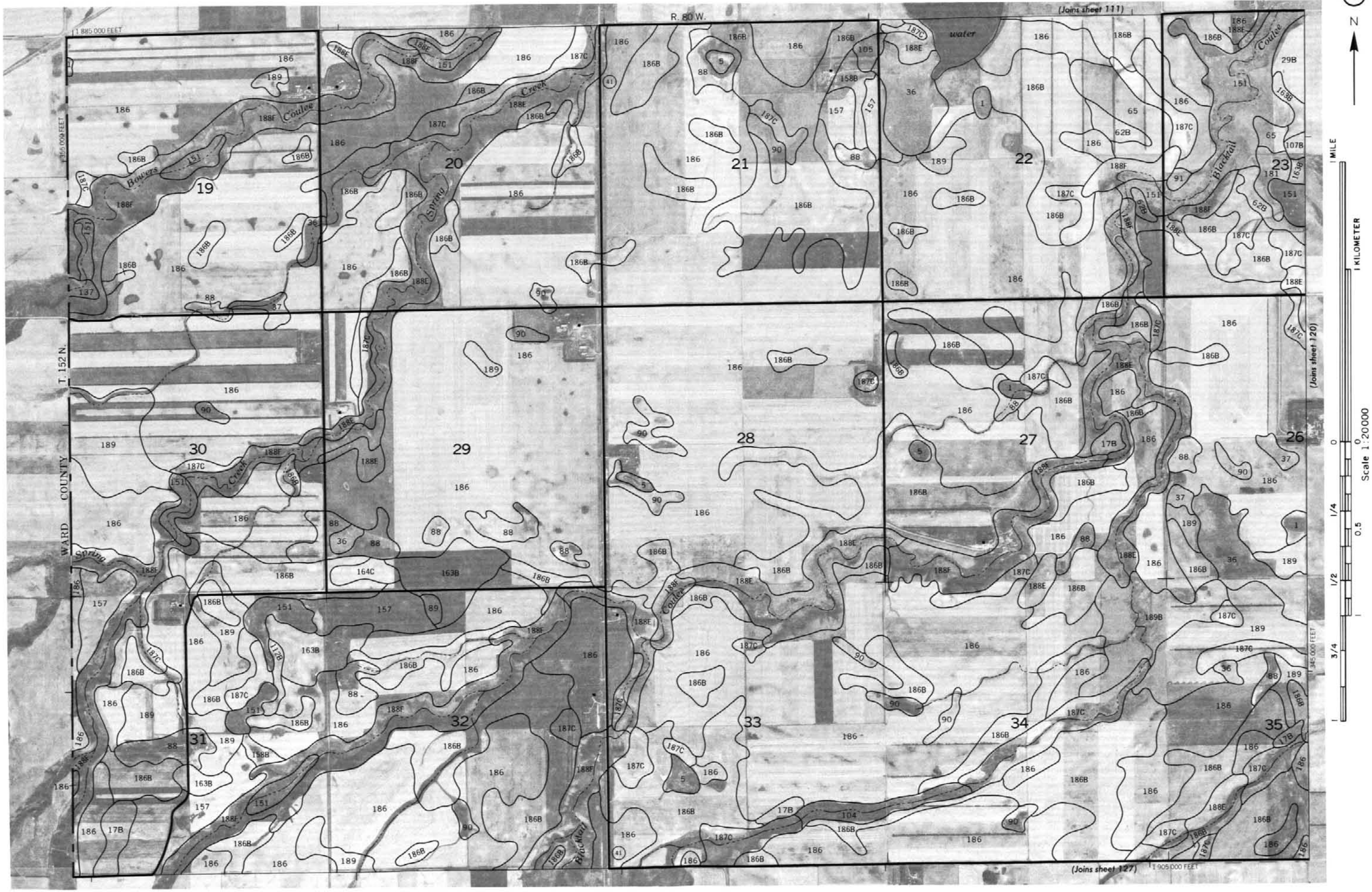


McHENRY COUNTY, NORTH DAKOTA NO. 117

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

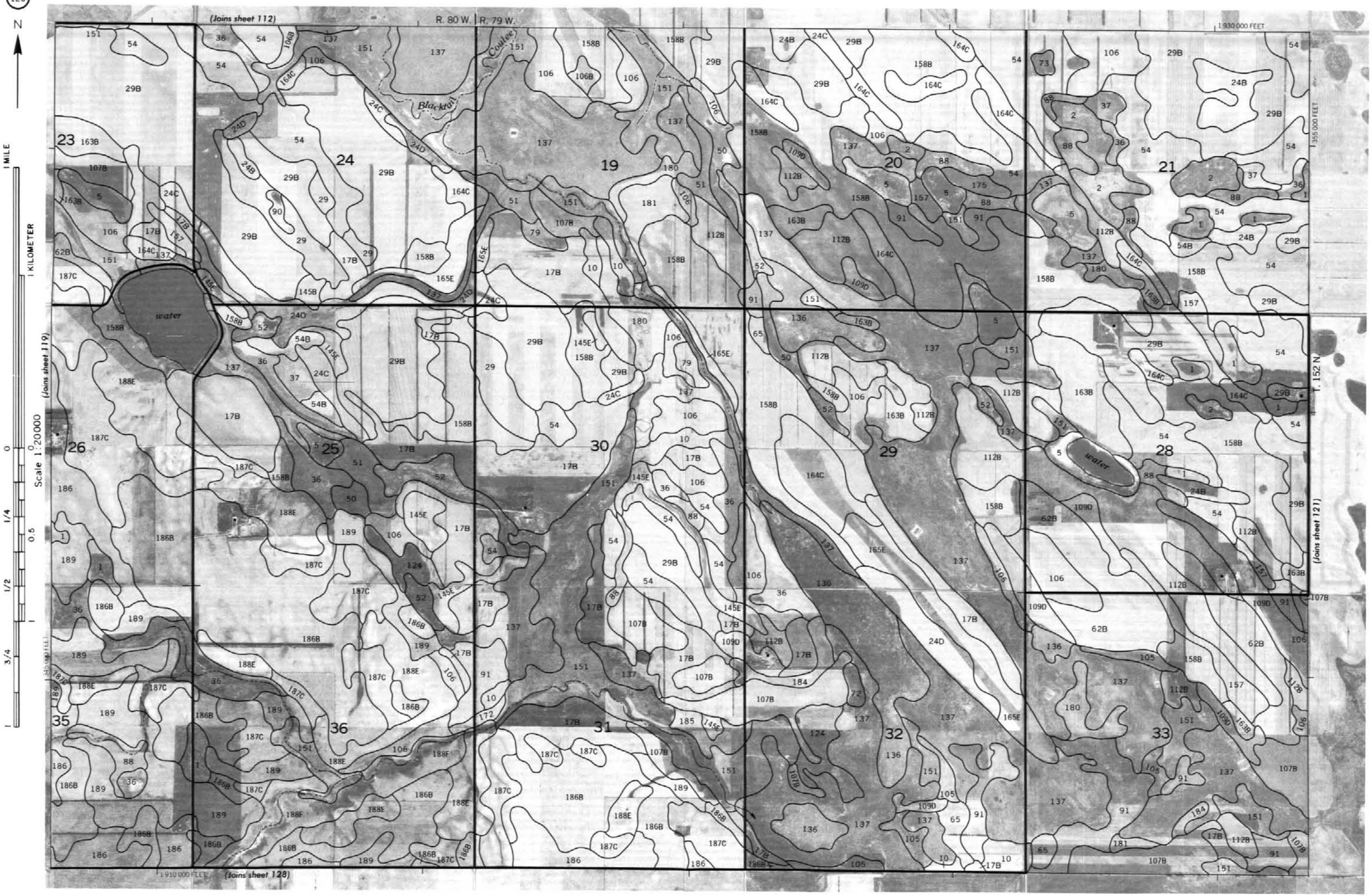


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

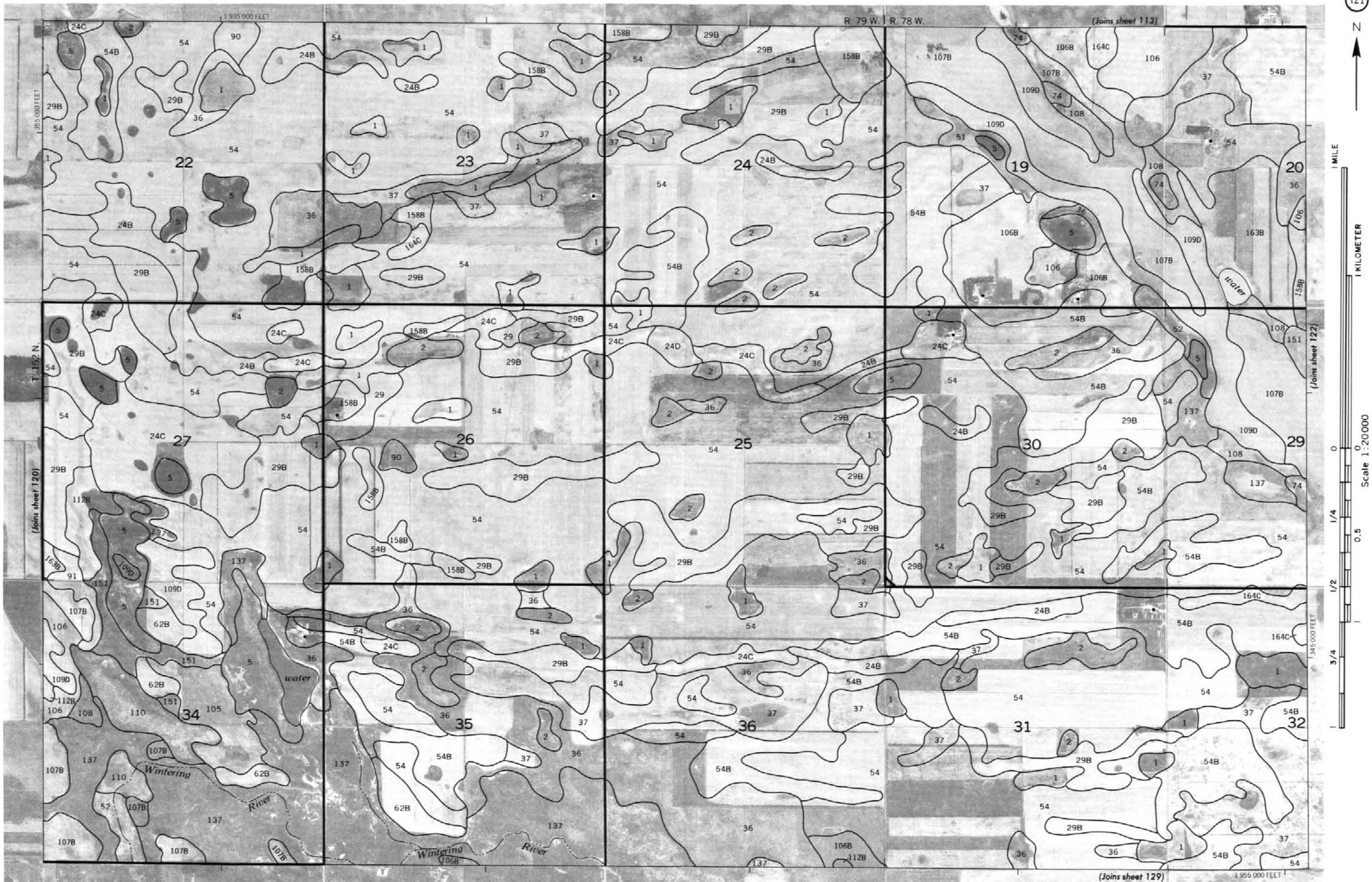


McHENRY COUNTY, NORTH DAKOTA NO. 119

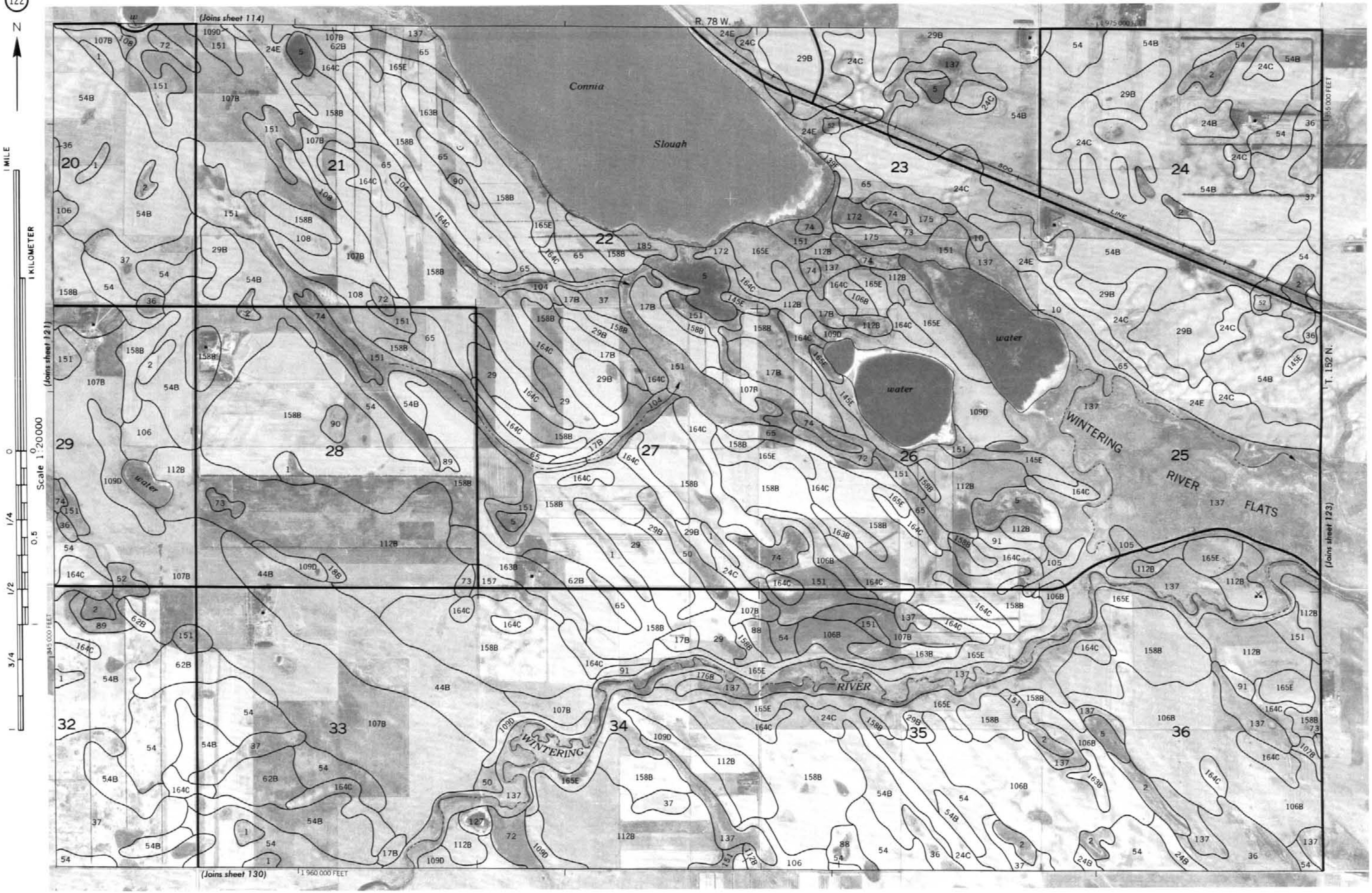
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

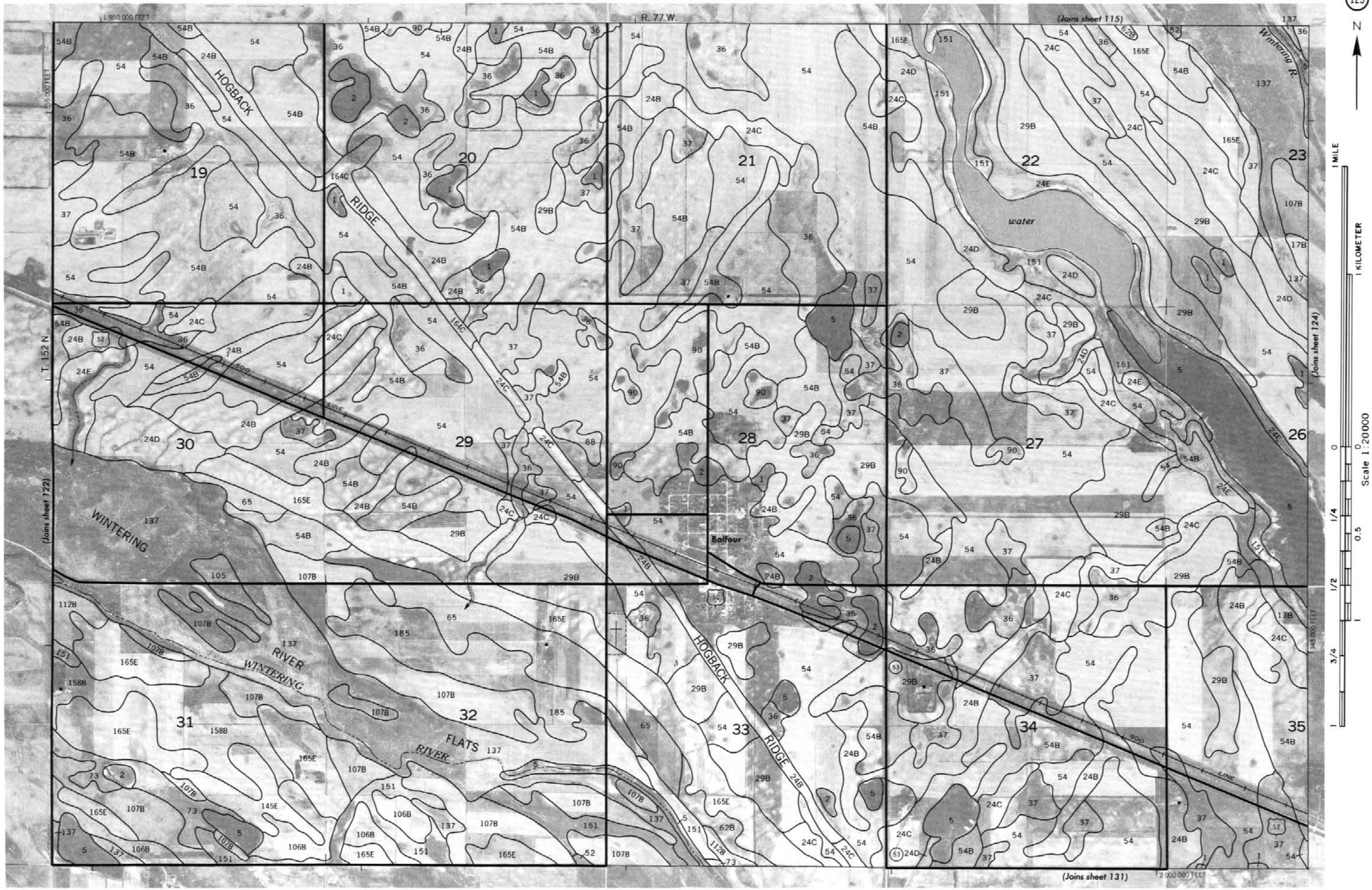


McHENRY COUNTY, NORTH DAKOTA NO. 121



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

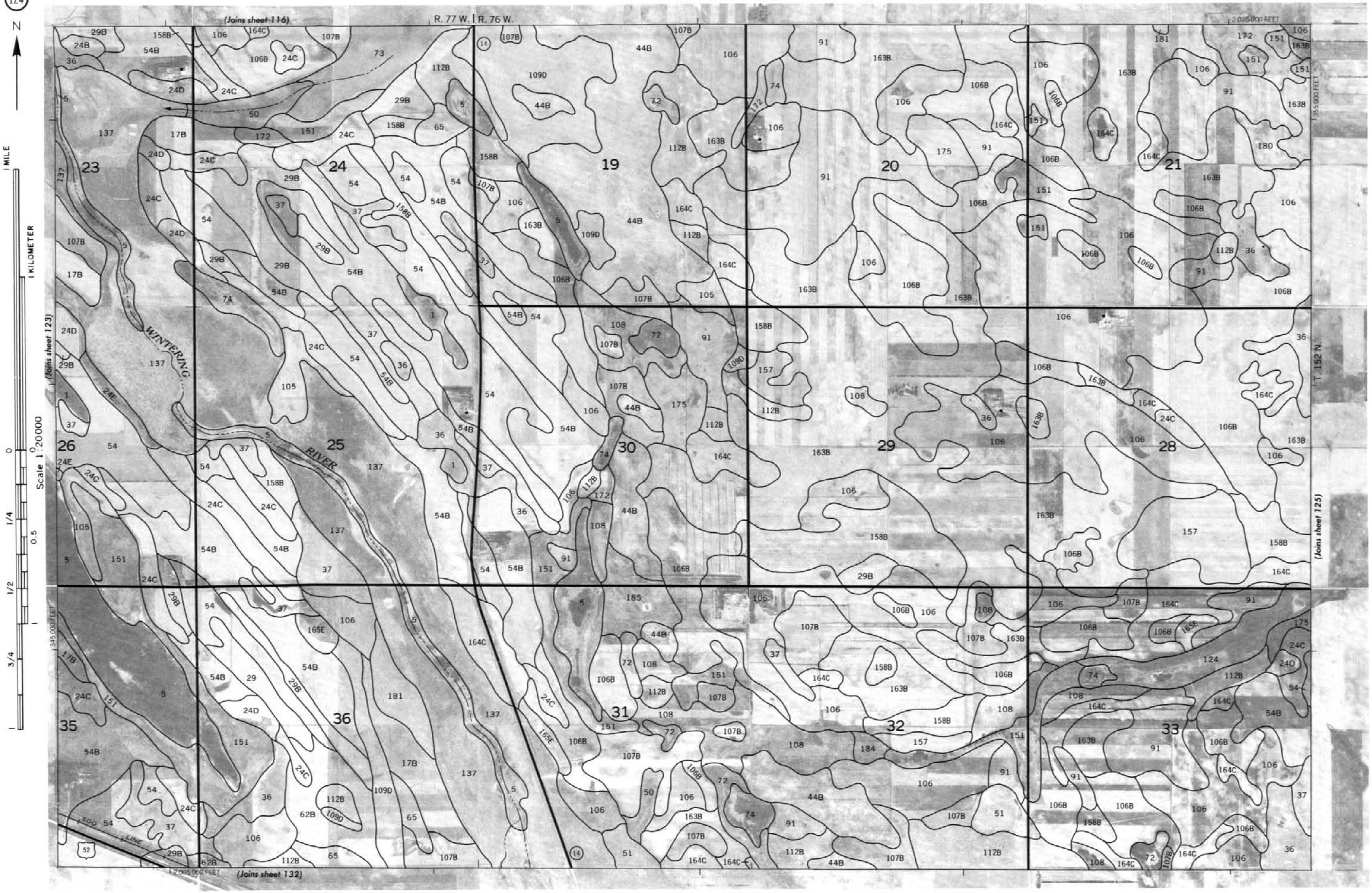
McHENRY COUNTY, NORTH DAKOTA NO. 122



McHENRY COUNTY, NORTH DAKOTA NO. 123

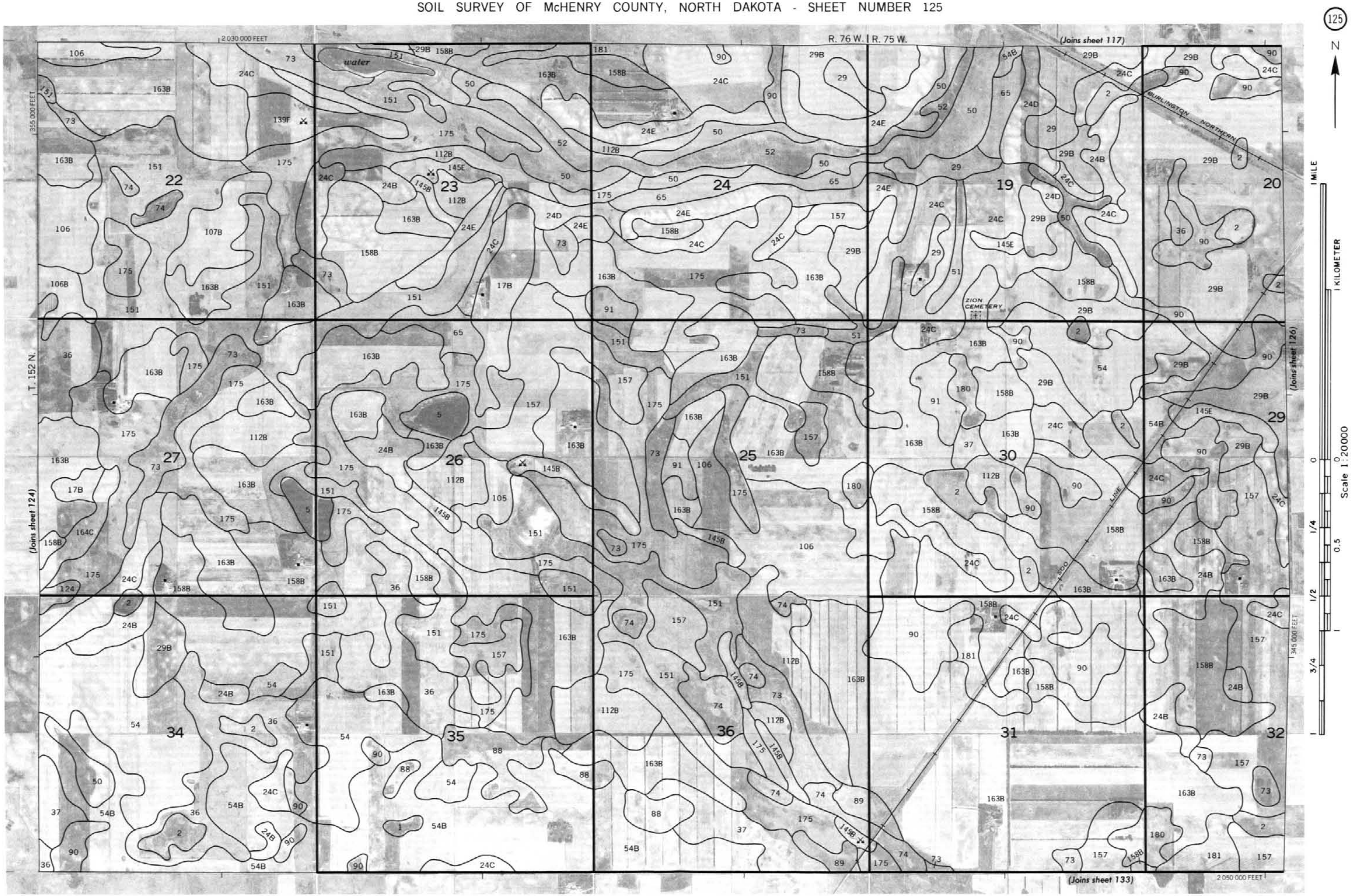
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

124



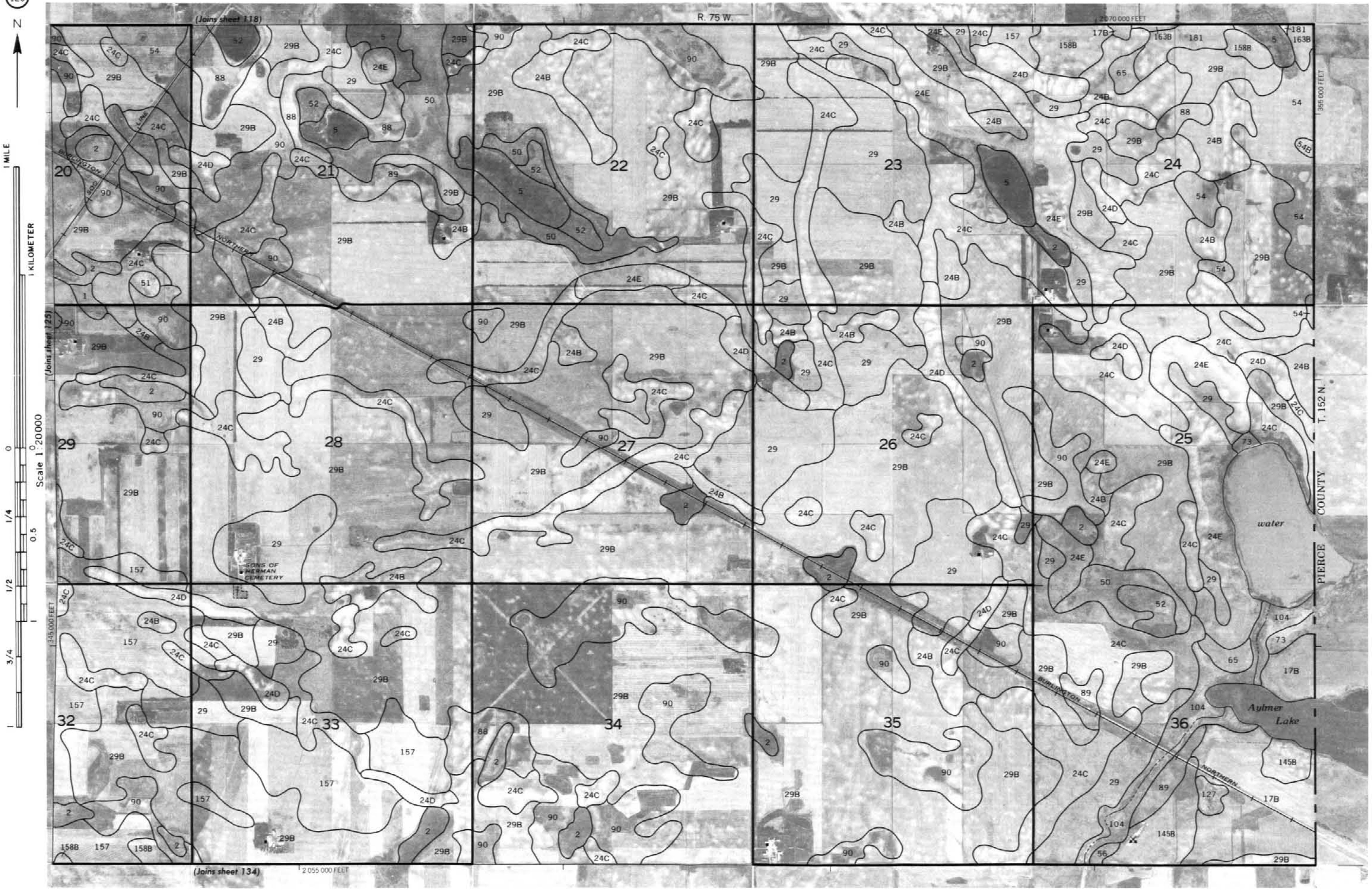
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 124



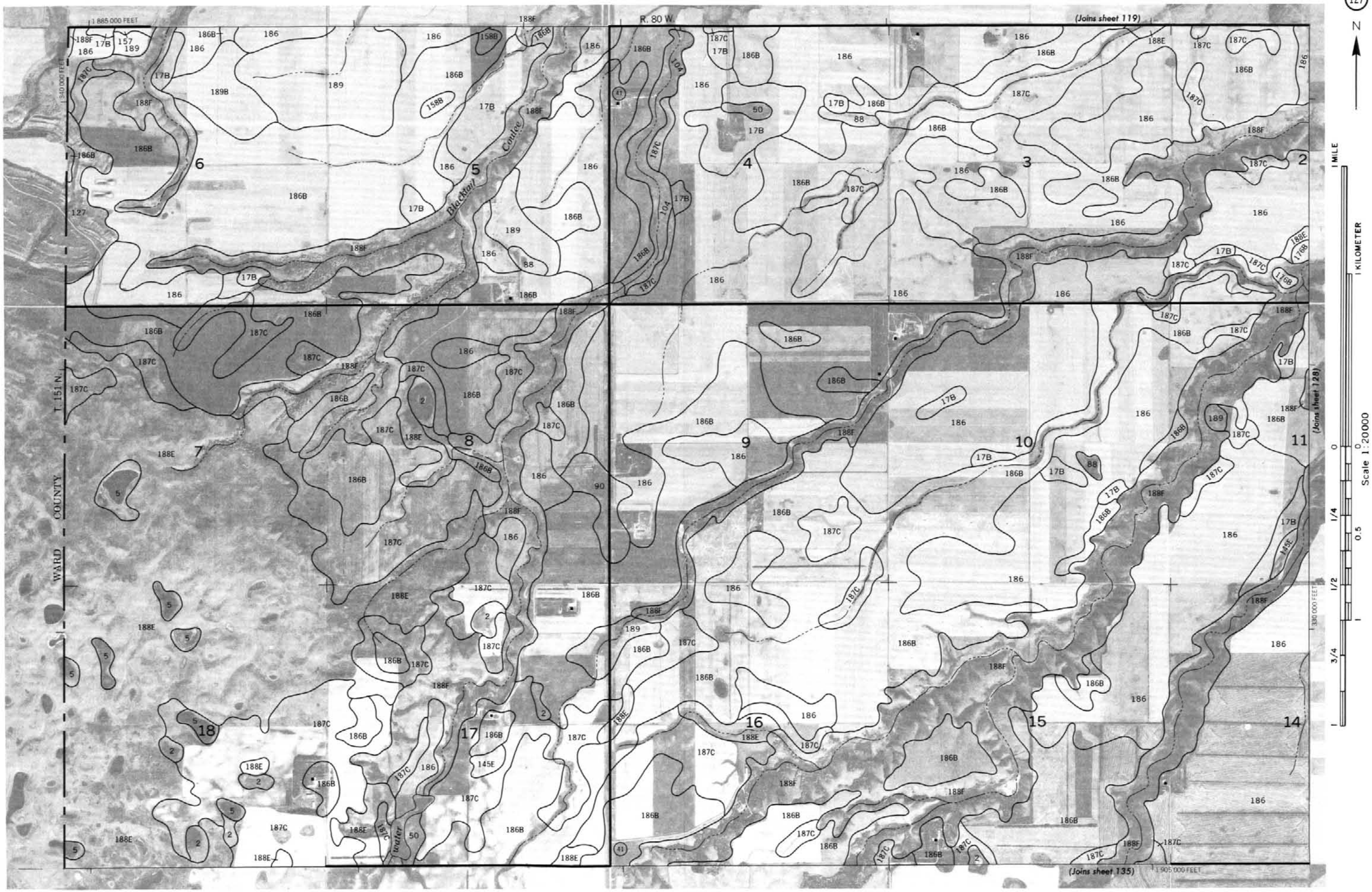
McHENRY COUNTY, NORTH DAKOTA NO. 125

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



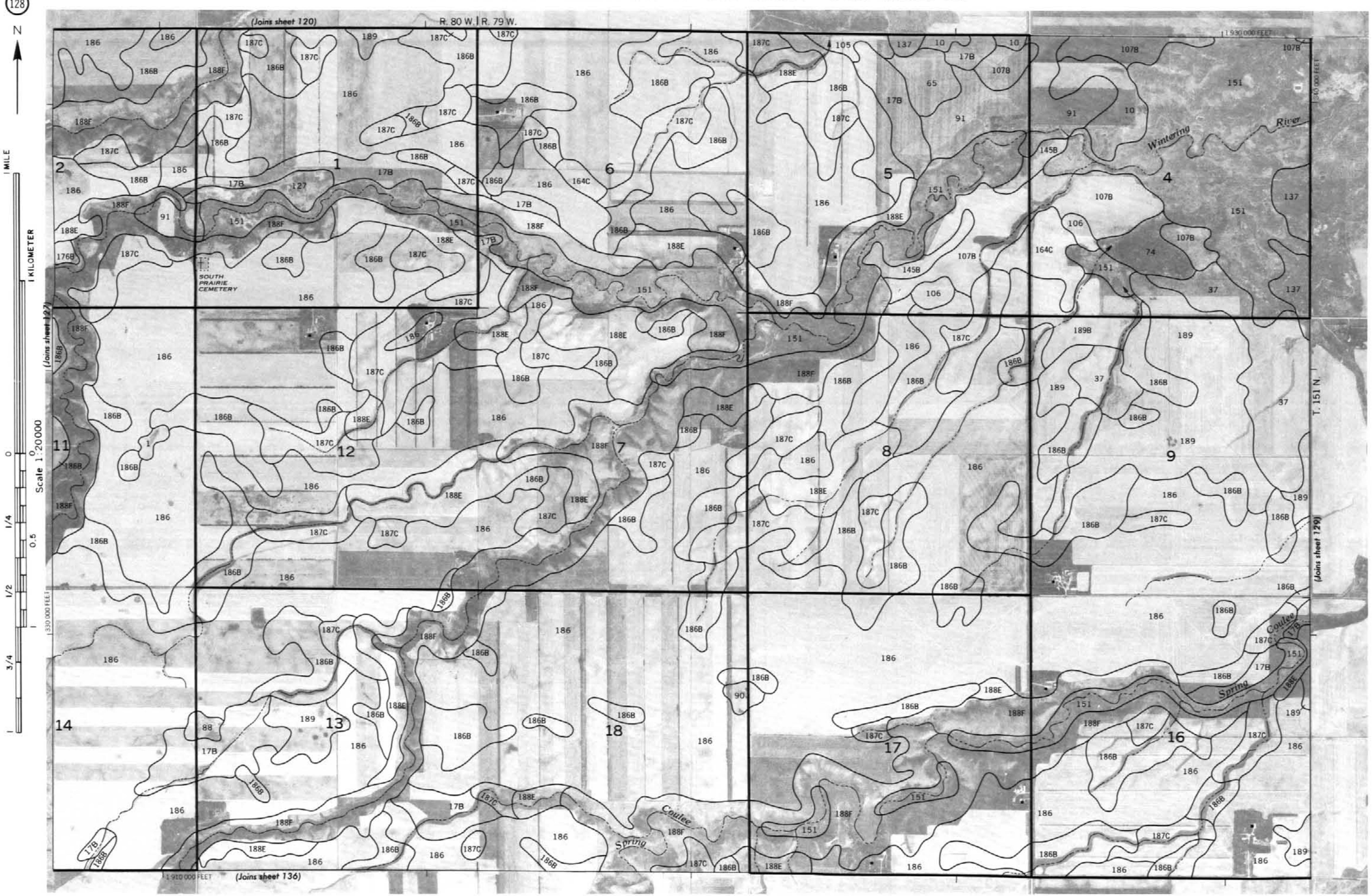
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

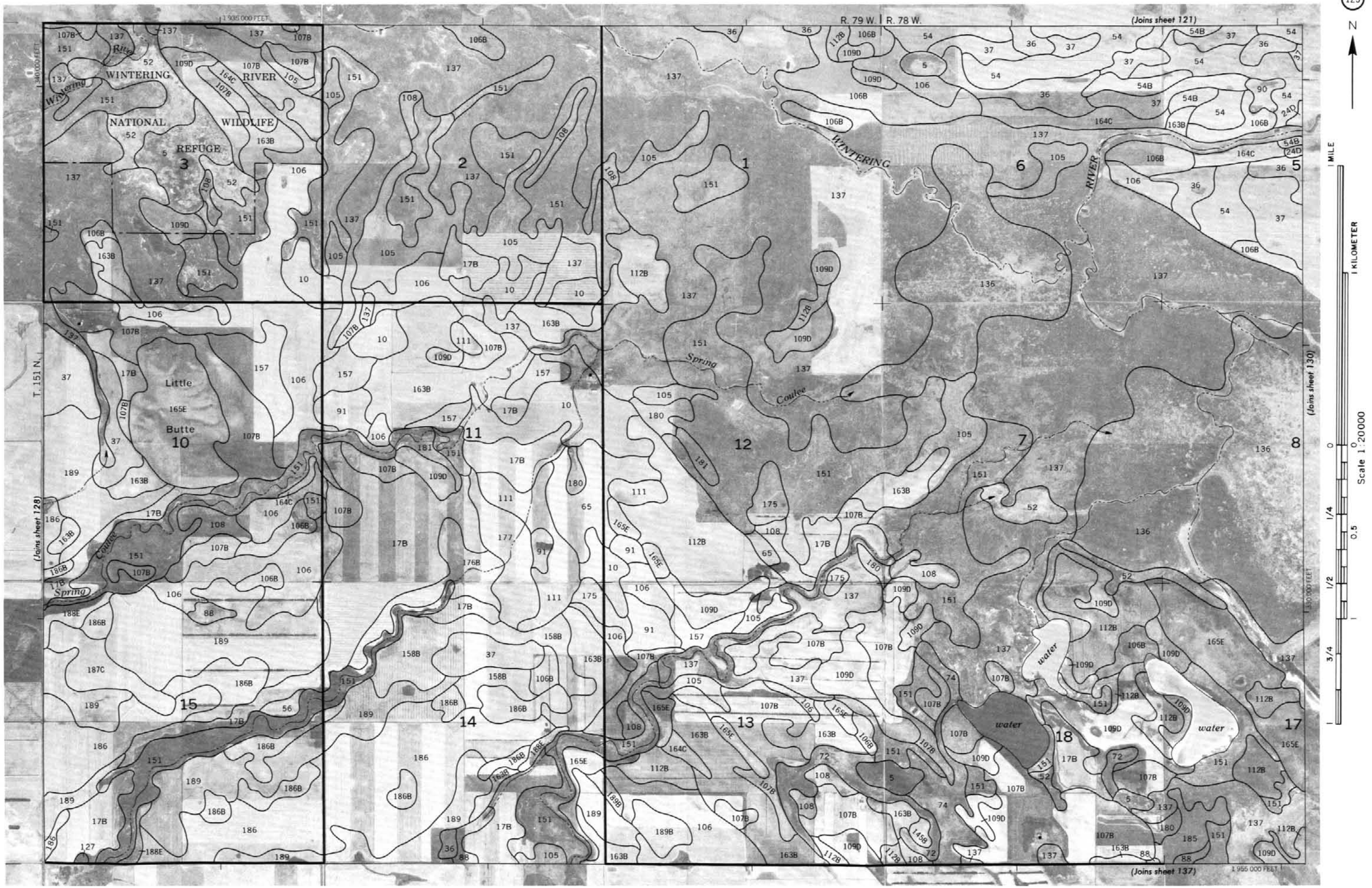
McHENRY COUNTY, NORTH DAKOTA NO. 126



McHENRY COUNTY, NORTH DAKOTA NO. 127

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

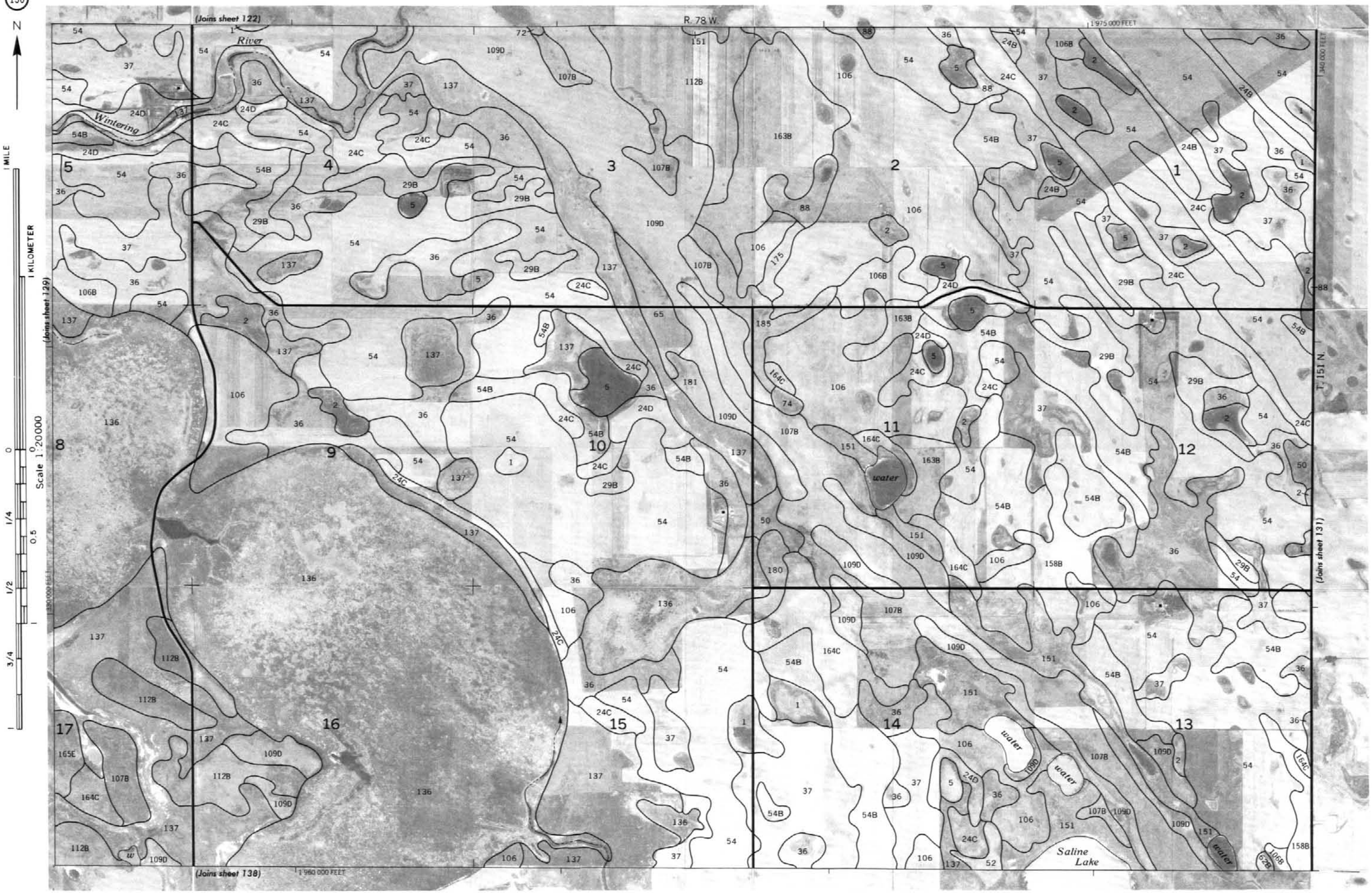

128
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 120)
R. 80 W. | R. 79 W.
1 930 000 FEET
340 000 FEET
330 000 FEET
1 910 000 FEET
(Joins sheet 127)
(Joins sheet 129)
(Joins sheet 136)
T. 151 N.
SOUTH PRAIRIE CEMETERY
Wintering River
Spring Coulee
Spring Coulee



McHENRY COUNTY, NORTH DAKOTA NO. 129

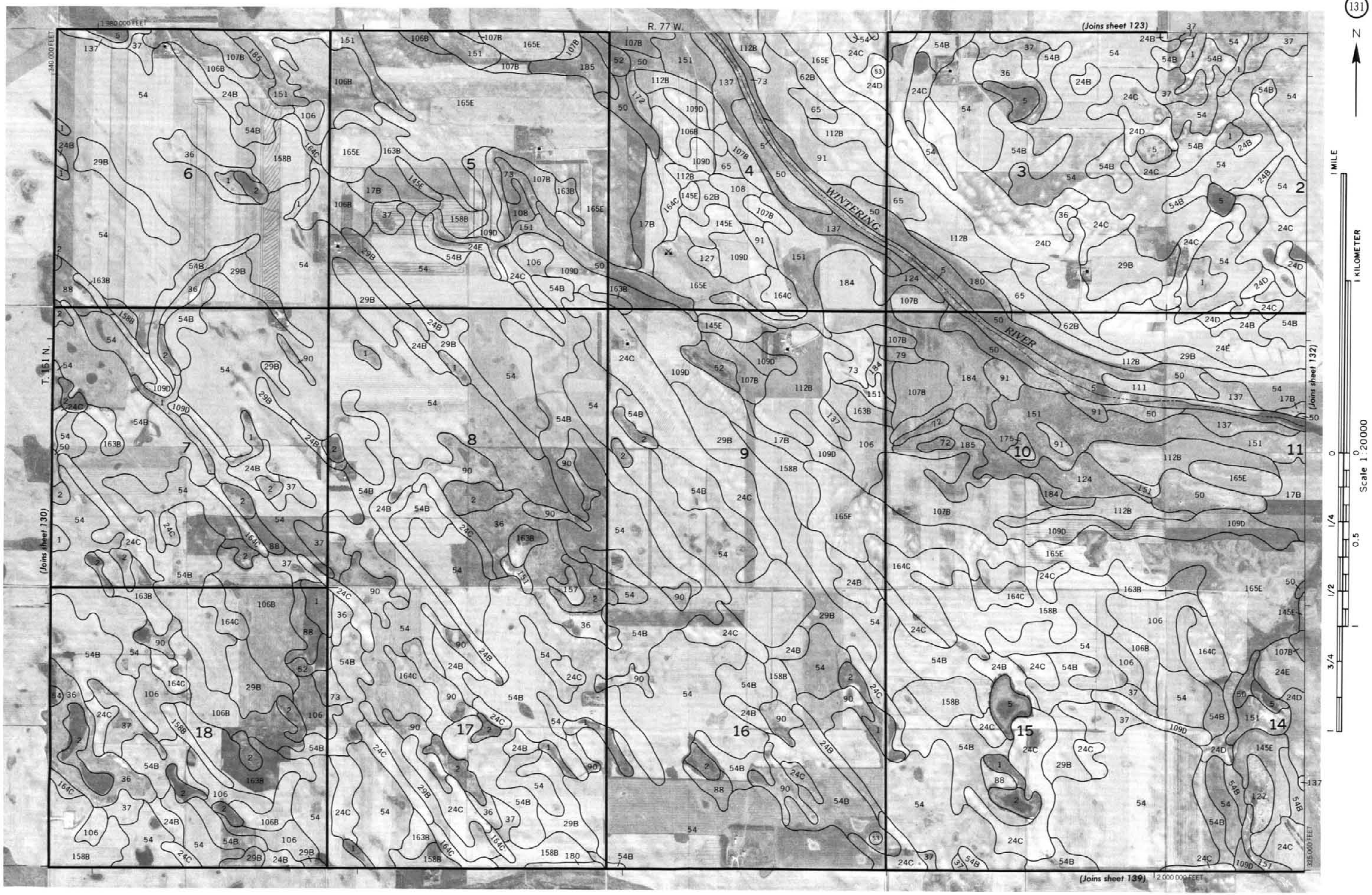
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 130



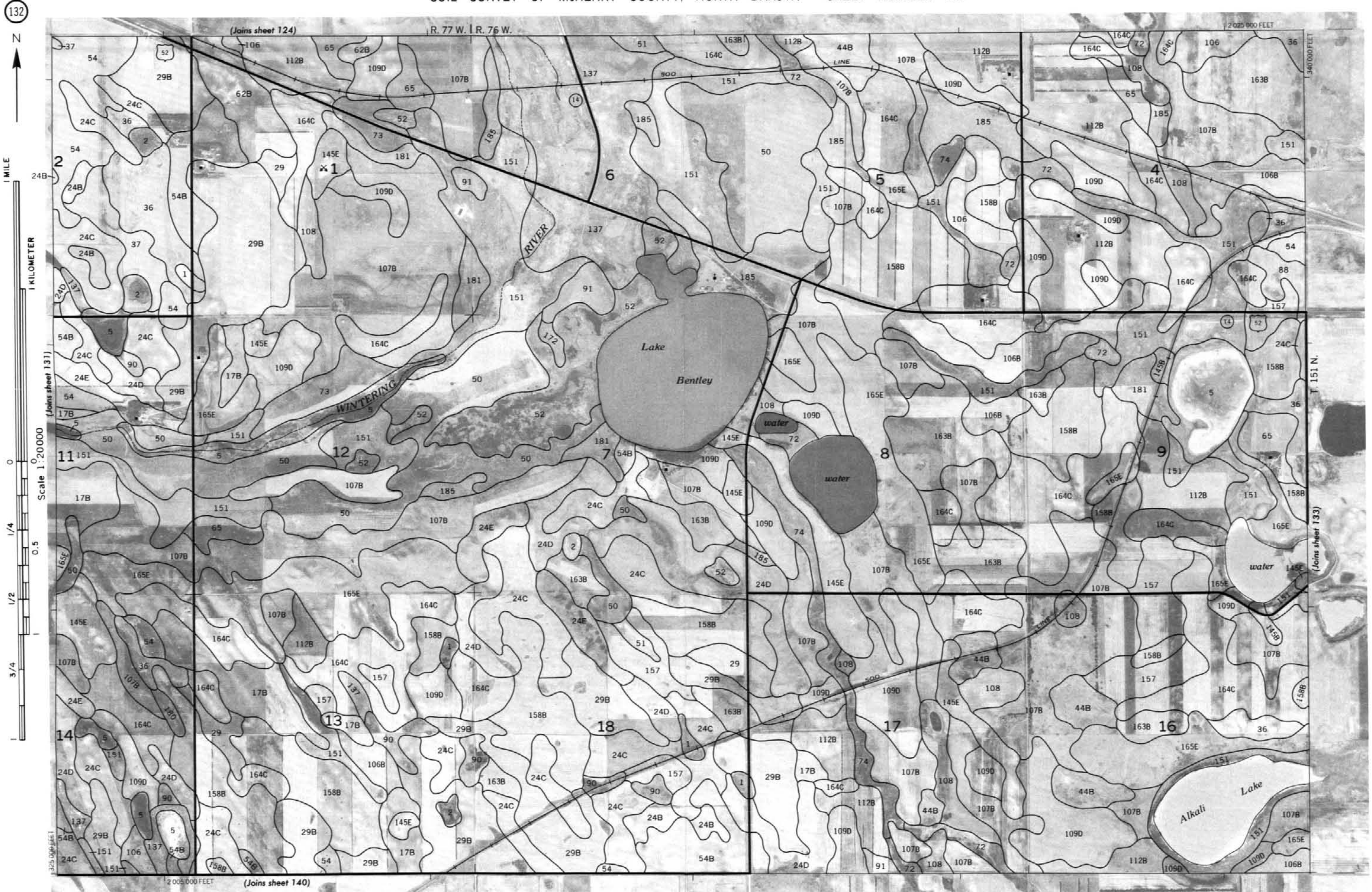
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 130

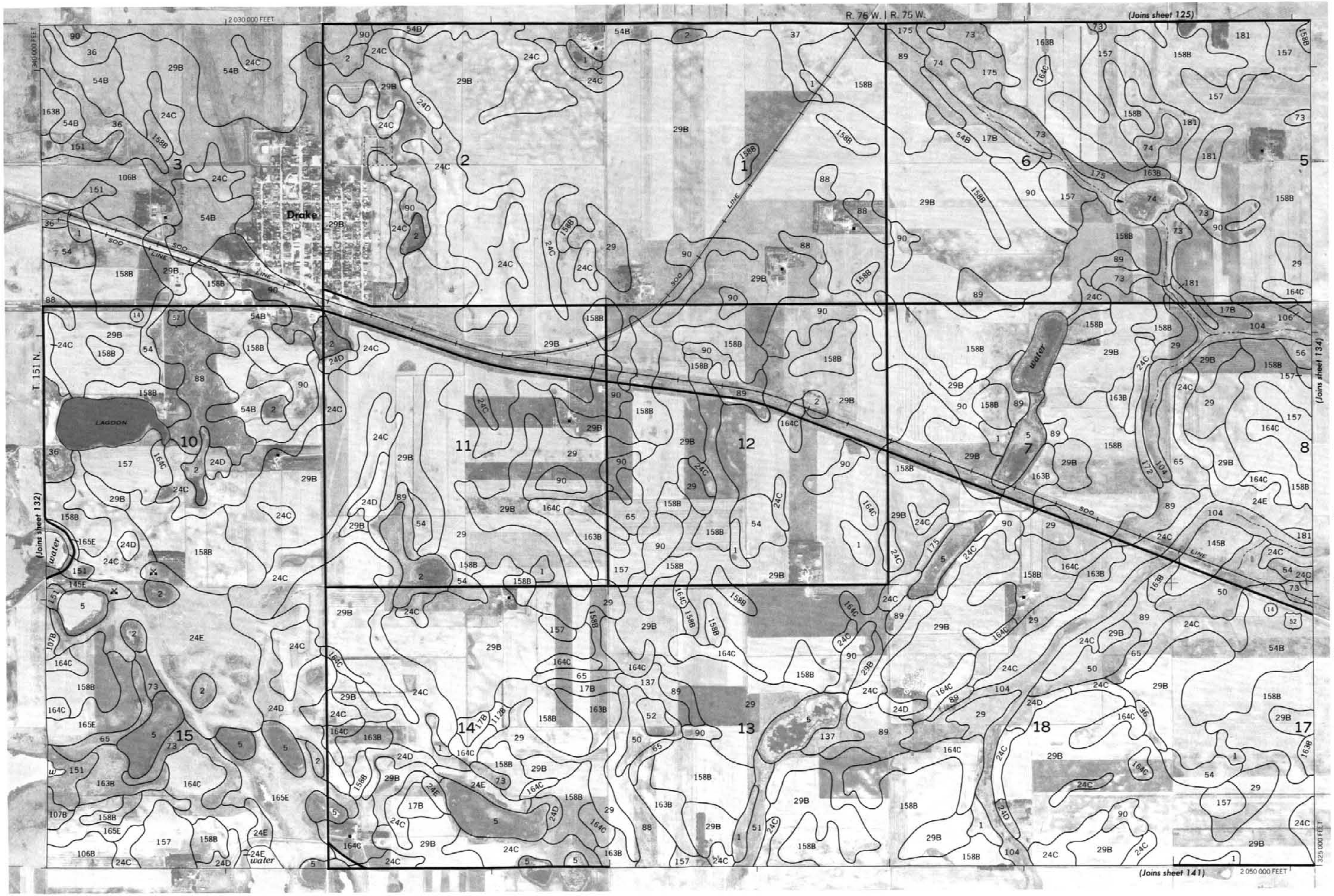


McHENRY COUNTY, NORTH DAKOTA NO. 131

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

1 MILE

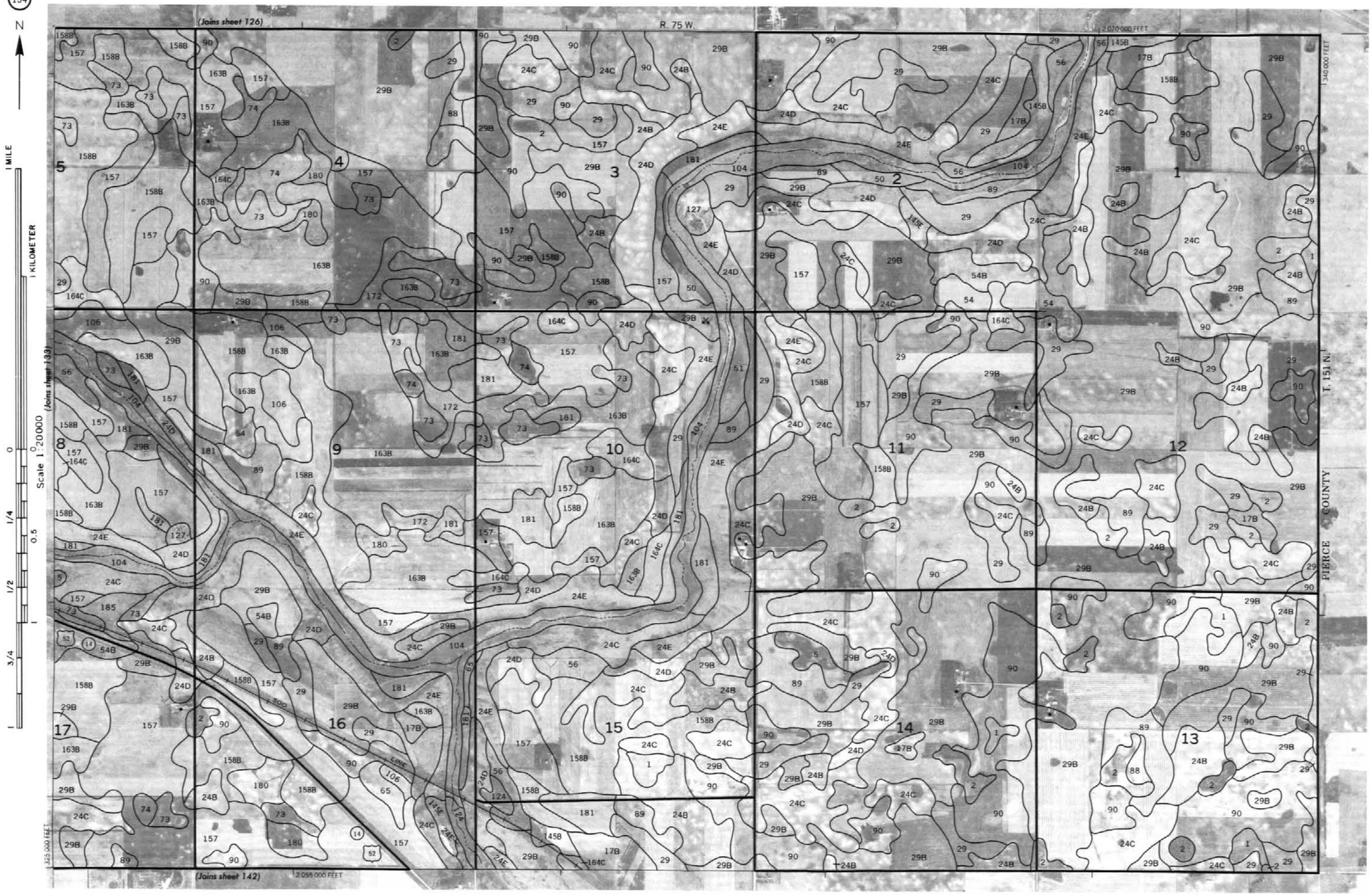
1 KILOMETER

Scale 1:20000

McHENRY COUNTY, NORTH DAKOTA NO. 133

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 134



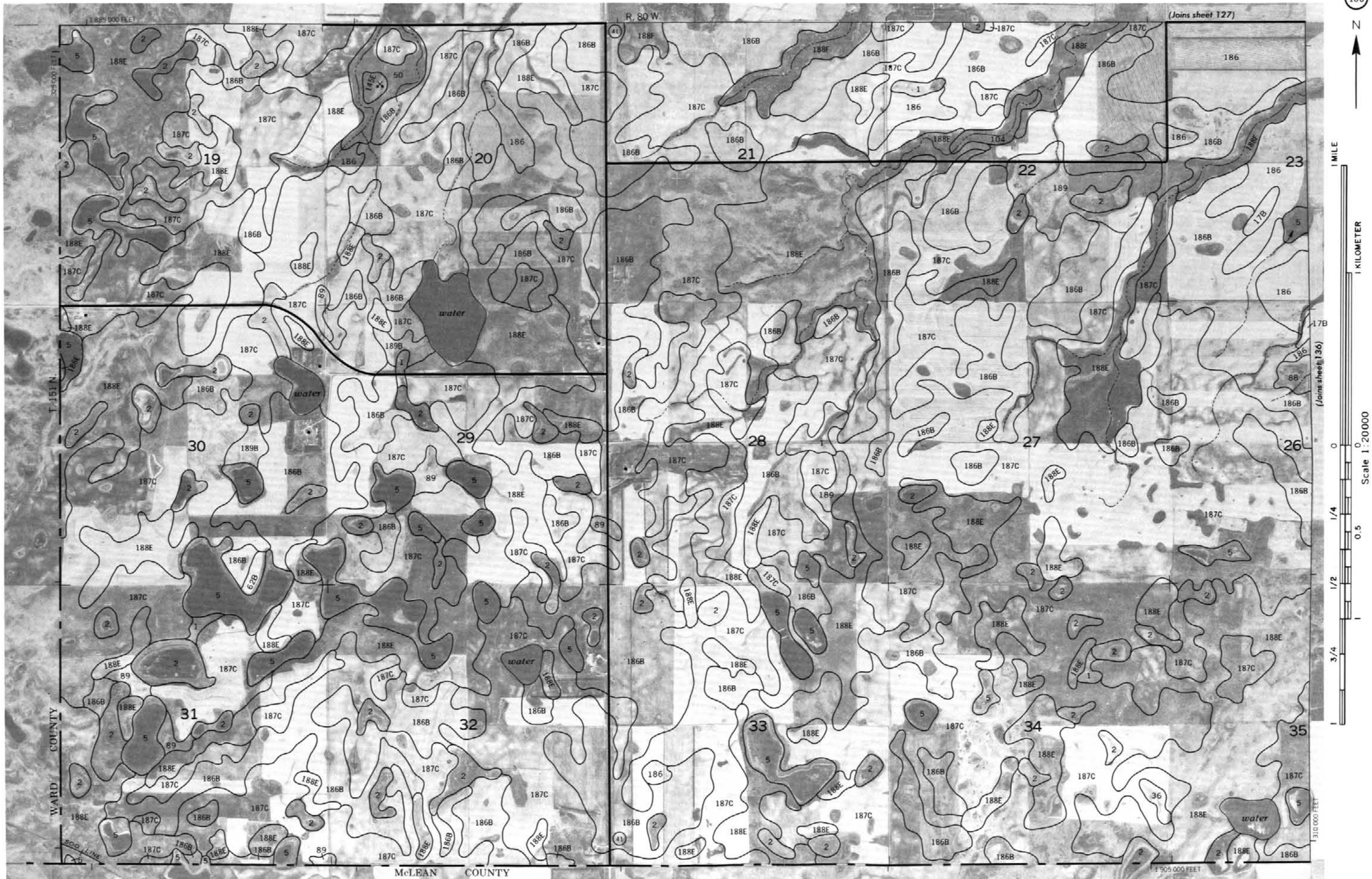
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 134

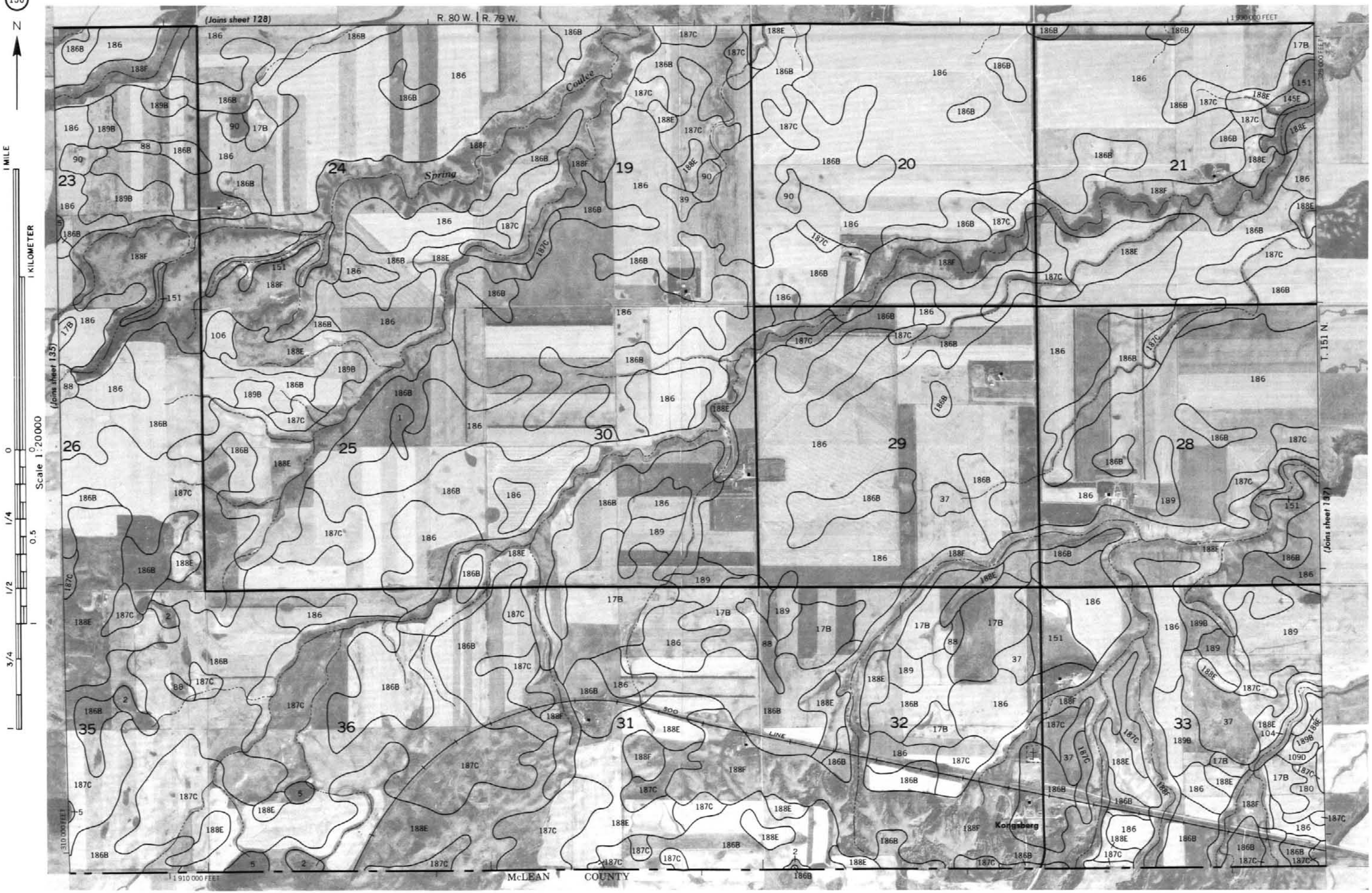
135

McHENRY COUNTY, NORTH DAKOTA NO. 135

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

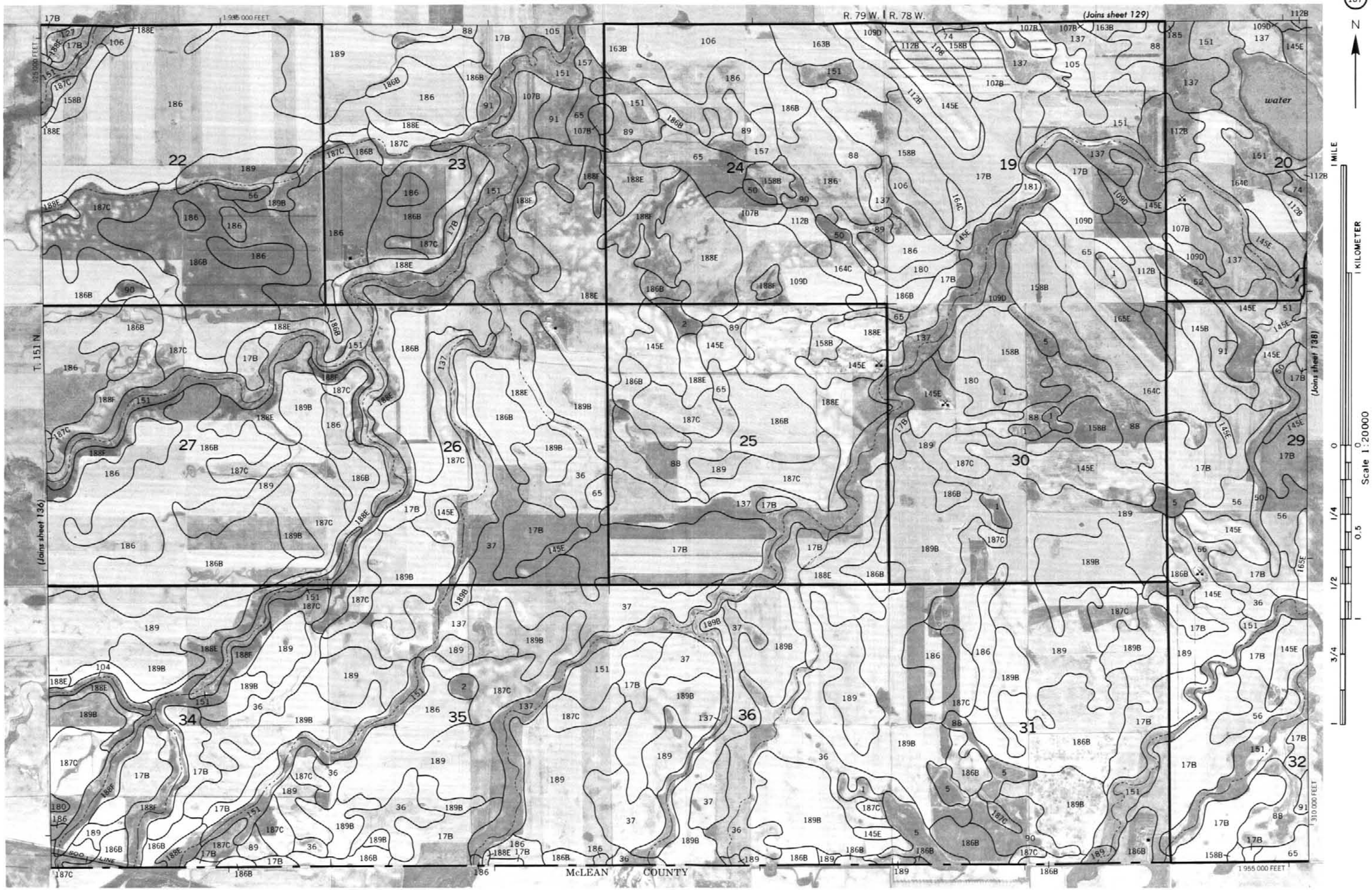


SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 136



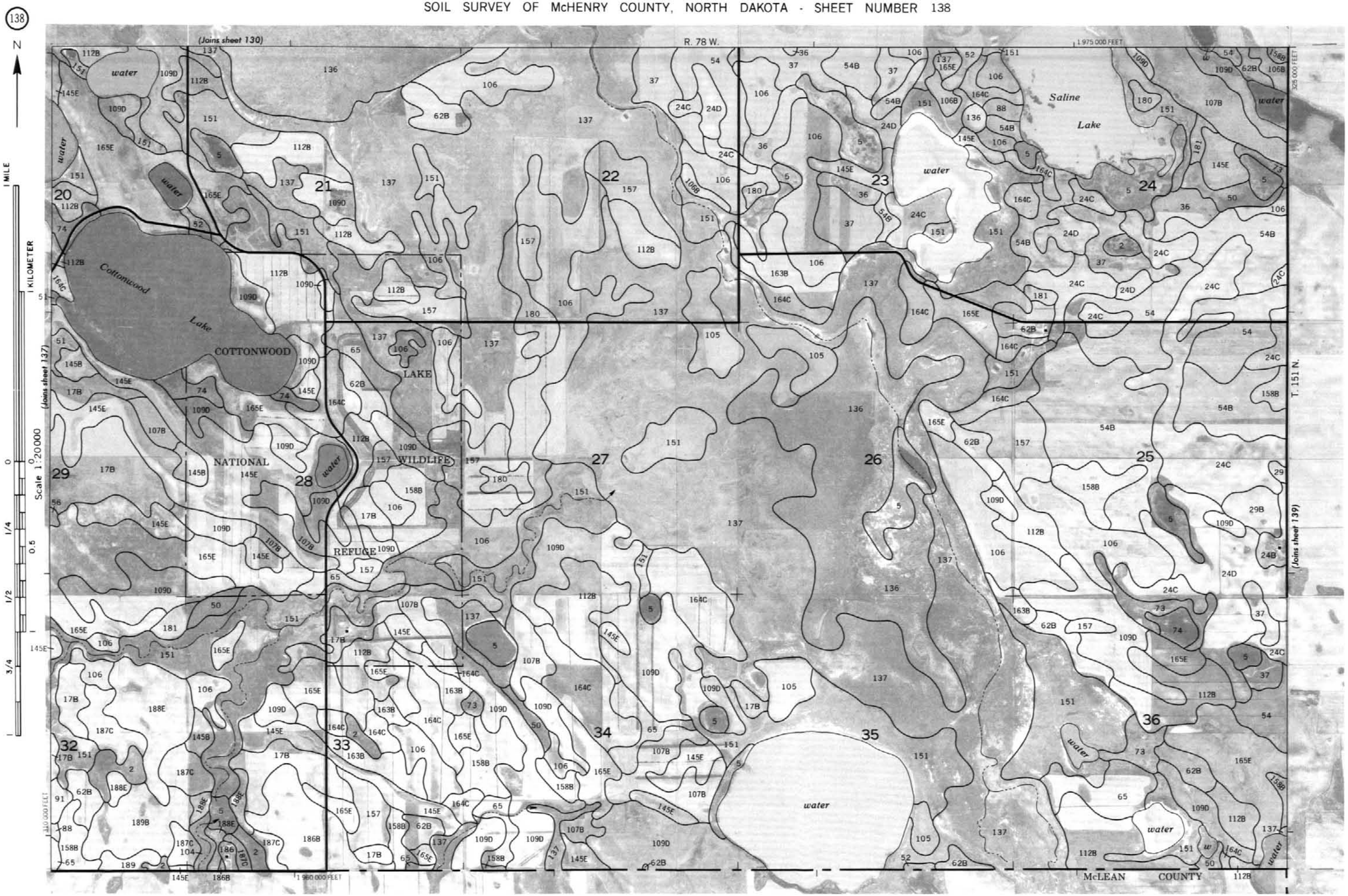
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 136

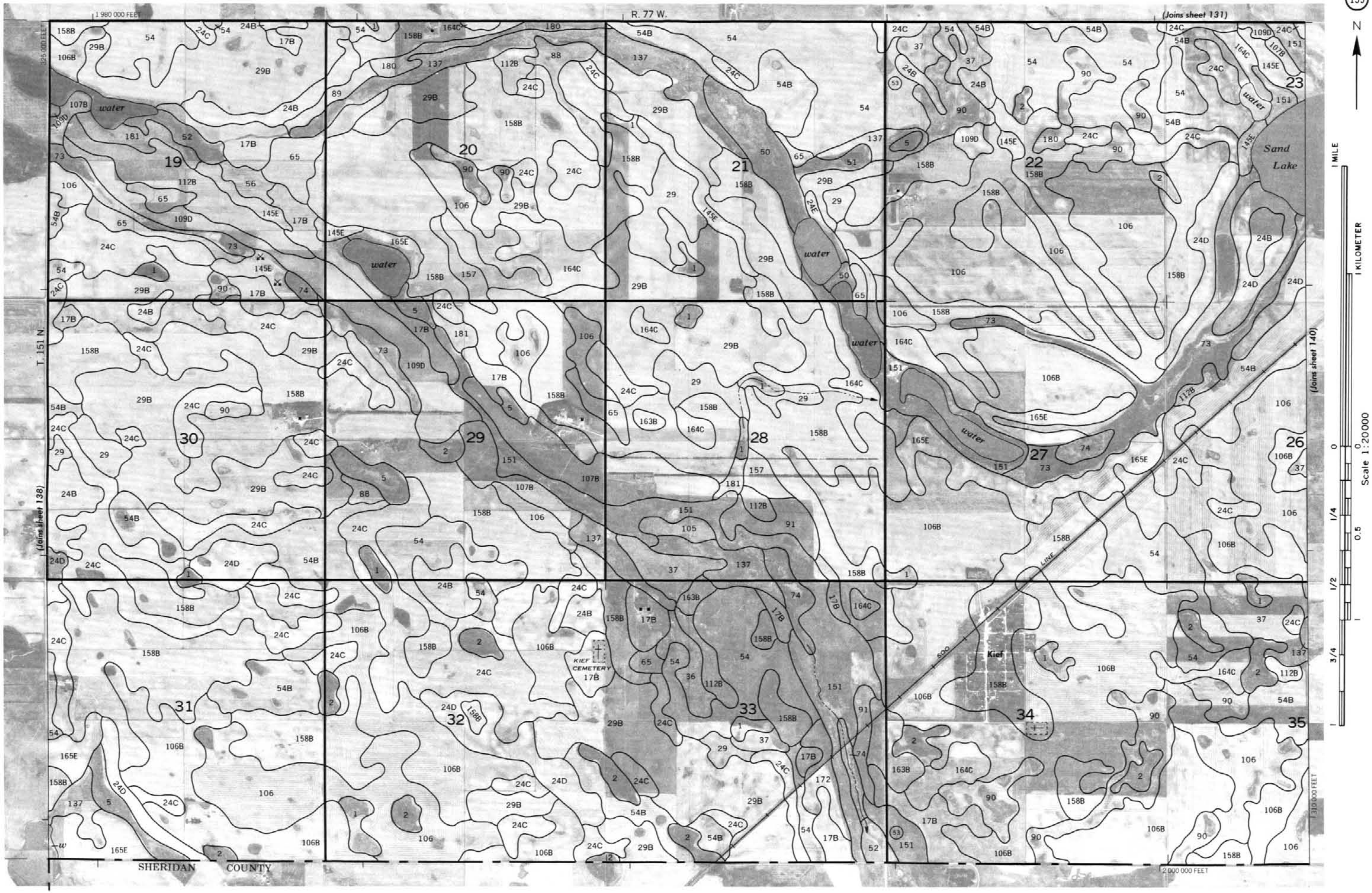


McHENRY COUNTY, NORTH DAKOTA NO. 137

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

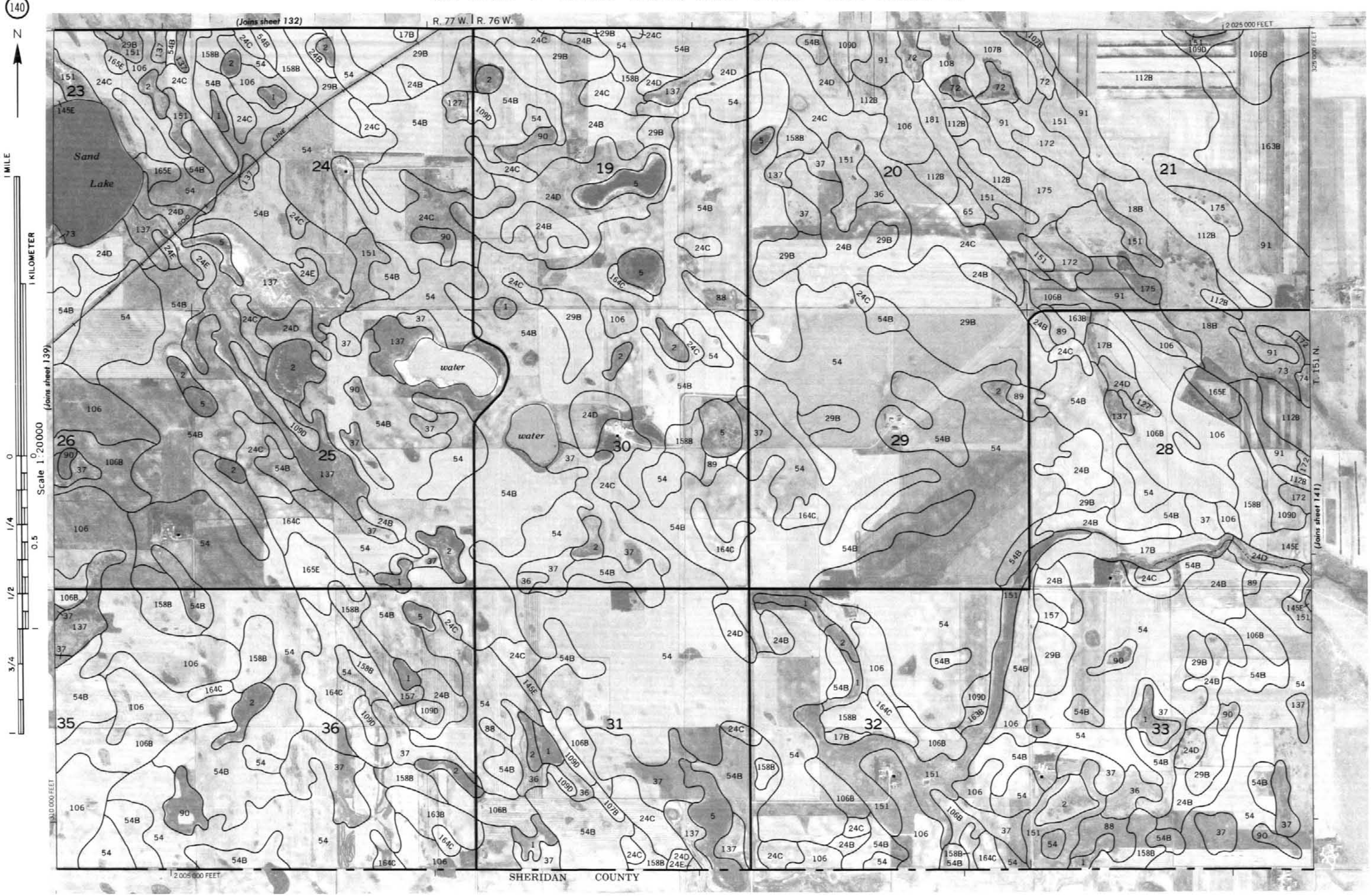


This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

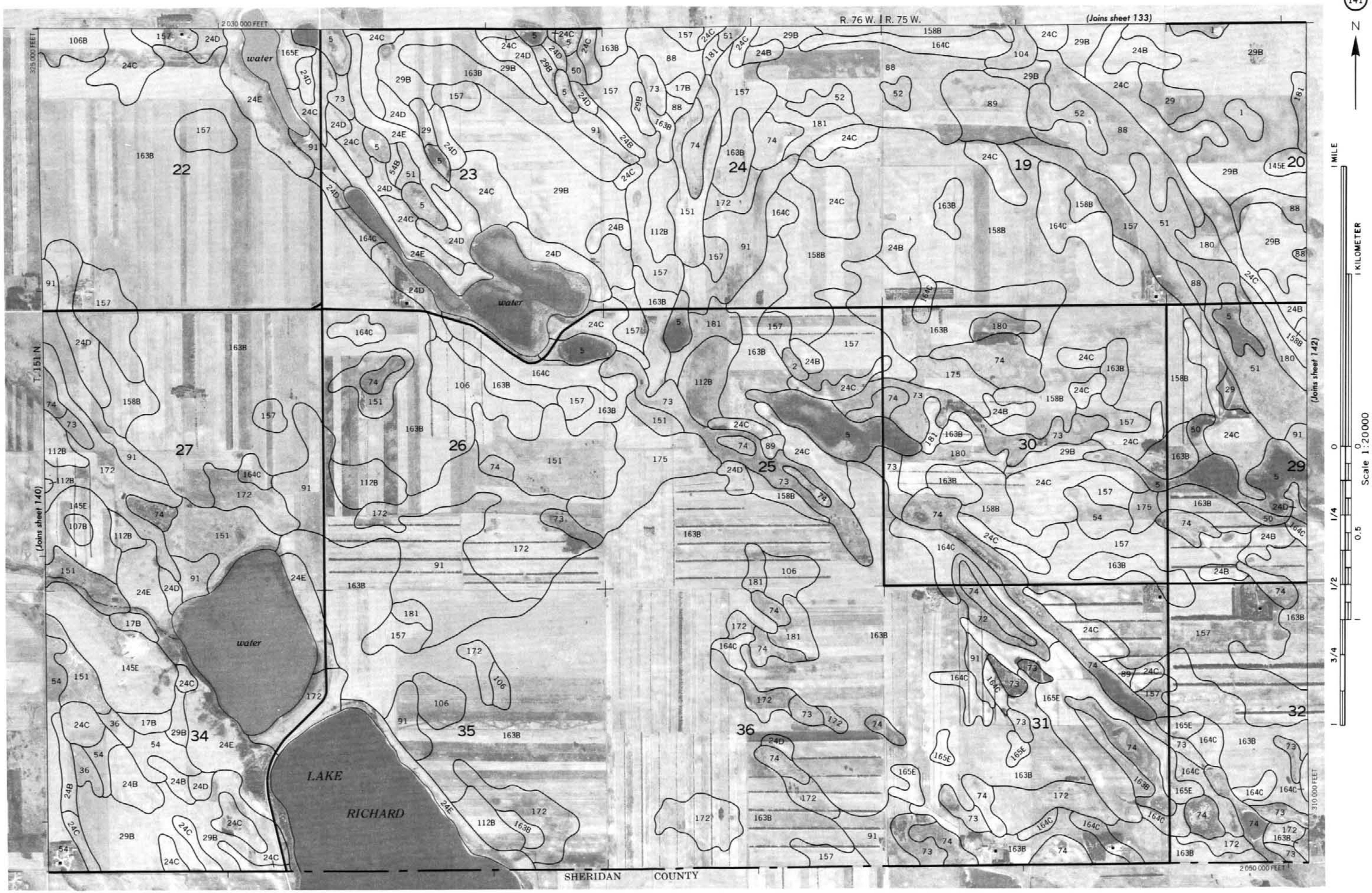


McHENRY COUNTY, NORTH DAKOTA NO. 139

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



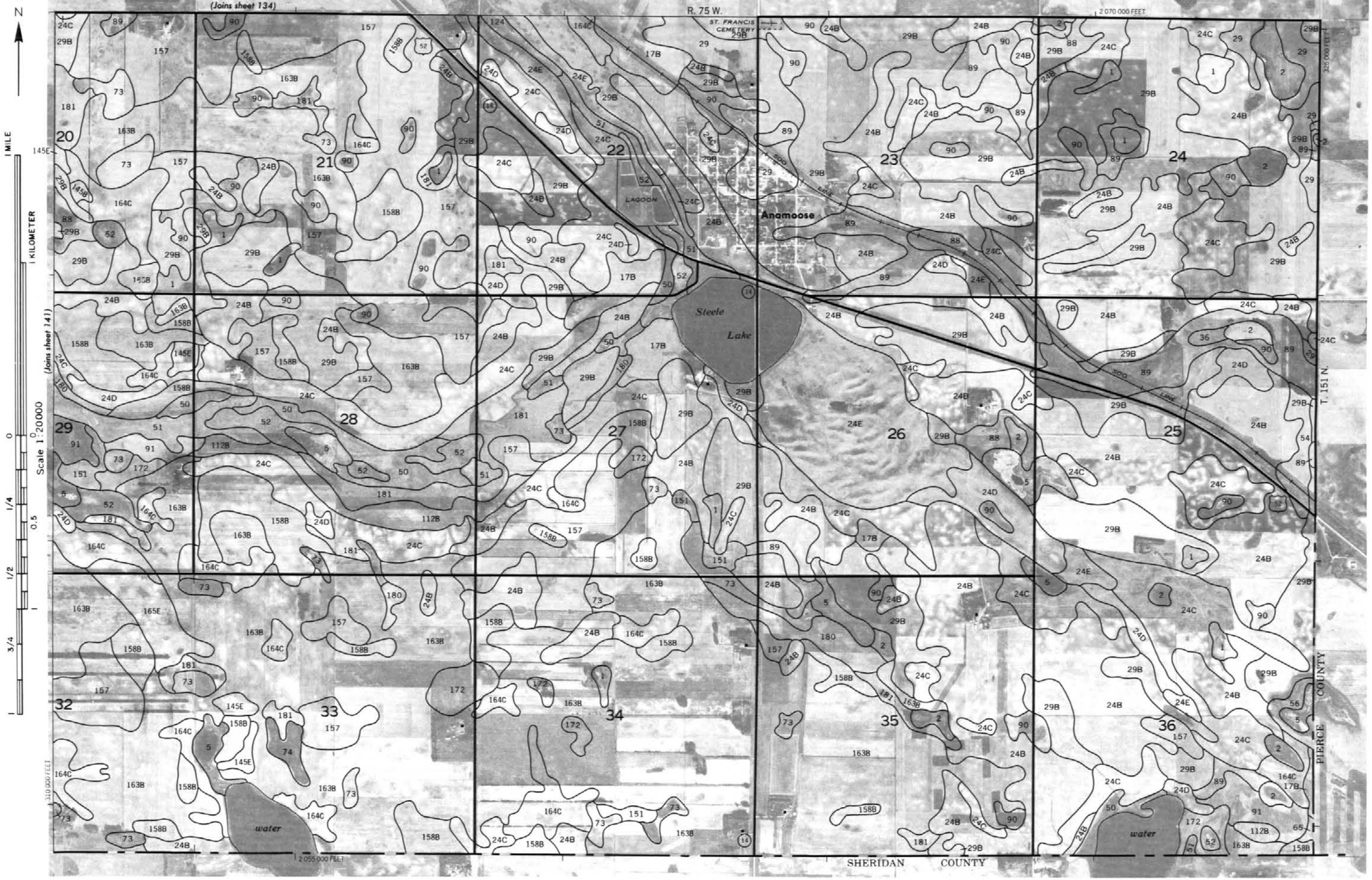
This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



McHENRY COUNTY, NORTH DAKOTA NO. 141

This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL SURVEY OF McHENRY COUNTY, NORTH DAKOTA - SHEET NUMBER 142



This soil survey map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

McHENRY COUNTY, NORTH DAKOTA NO. 142